Chapter 2

Conceptual Framework and Hypotheses

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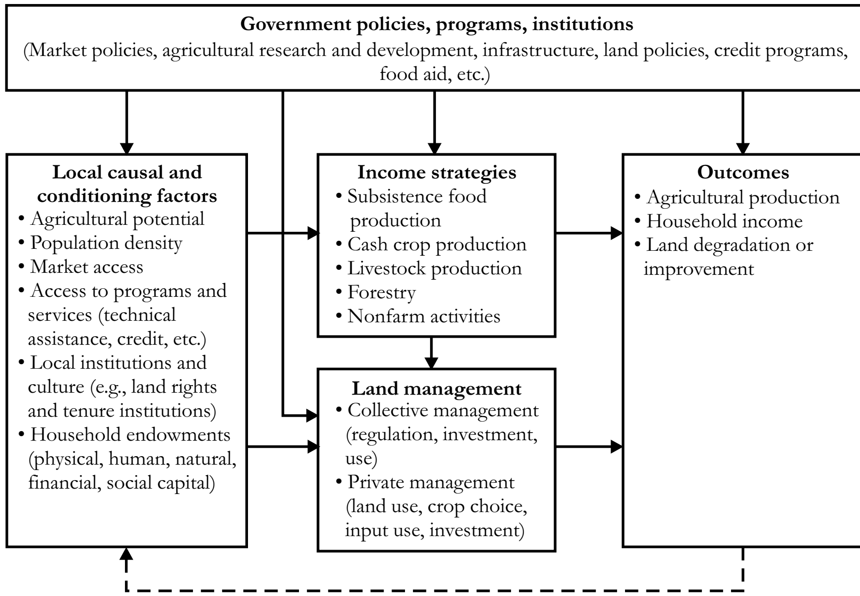
In this chapter we introduce the conceptual framework that underlies the case studies presented in this book and discuss hypotheses about the effects of key factors on community and household decisions concerning income strategies and land management. We also discuss the influence of such decisions on outcomes such as agricultural production, household income, and land degradation (or improvement). This chapter is adapted from Scherr et al. (1996); Pender, Place, and Ehui (1999); Pender, Scherr, and Durón (2001); and Nkonya et al. (2004). The conceptual framework considers the effects of dynamic driving forces of change, such as population growth and changes in access to technology, markets, infrastructure, and services, as well as of more slowly changing conditioning factors such as agricultural potential, local institutions, and culture. We also consider the influence of government policies, programs, and institutions, which may influence income strategies, land management, and outcomes in many ways at different levels by affecting the driving forces and conditioning factors at the local level, by directly promoting or inhibiting different income strategies and land management practices, or by directly affecting outcomes (e.g., through food aid). We argue that the impacts of many factors are likely to be context-dependent, emphasizing the importance of empirical research in specific contexts, though some unambiguous hypotheses are derived. In general, policy and program interventions are likely to involve trade-offs among the objectives of increasing agricultural productivity, increasing household income, and reducing land degradation.

Figure 2.1 Factors affecting income strategies, land management, and their implications



Conceptual Framework

To address the objectives and the research issues identified in the preceding chapter, we developed a conceptual framework, illustrated in Figure 2.1, that served as a guide for developing hypotheses tested during the various research activities reported in this book. The conceptual framework for this research on sustainable land management draws from theories of induced technical and institutional innovation in agriculture that explain changing management systems in terms of changing microeconomic incentives facing farmers as a result of changing relative factor endowments (Boserup 1965; Hayami and Ruttan 1985; Binswanger and McIntire 1987; Pingali, Bigot, and Binswanger 1987). Additional variables that are also important determinants of resource management have been included, inspired by theories of collective action (Olson 1965; Ostrom 1990; Baland and Platteau 1996), market and institutional development (North 1990), and agricultural household models (Singh, Squire, and Strauss 1986; de Janvry, Fafchamps, and Sadoulet 1991).

Outcomes

The key outcomes of interest to policy makers include outcomes such as agricultural productivity, household income and household welfare indicators, and changes

in natural resource conditions, particularly land degradation or improvement. Our interest in this framework is to assess the ultimate impacts of policies, programs, and institutions on these outcomes and the extent to which there may be trade-offs or complementarities among outcomes. For example, government policies that prevent sales or exchanges of lands may be effective in preventing the dispossession of lands from poor smallholders but be ineffective in improving the welfare of the poor because of their inability to put the land to productive alternative use. Another example is that a strict regulatory approach (such as preventing farmers from planting annual crops on sloping lands) may be effective in reducing soil erosion but may also have severe implications for agricultural production, food insecurity, and poverty. On the other hand, there may be "win-win-win" strategies such as promotion of improved technologies or markets that promote greater production and incomes as well as improved resource conditions.

These outcomes not only are important for people at present but also affect households' endowments and opportunities in the future (indicated by the arrow from outcomes to the factors affecting income strategies and land management in Figure 2.1). For example, increases in agricultural production and income can facilitate greater investment in different types of capital, whether physical (e.g., purchase of livestock or equipment), financial (e.g., monetary savings), or human capital (e.g., investments in education), and improvements in land quality that represent an investment in natural capital. Interventions or other changes that lead to improved agricultural productivity, household income, and natural resource conditions may foster a "virtuous circle" or "upward spiral" out of low productivity, poverty, and land degradation; conversely, negative outcomes may contribute to a "downward spiral" (Durning 1989; Leonard 1989; Cleaver and Schreiber 1994; Pinstrup-Andersen and Pandya-Lorch 1994).

Whether such upward or downward spirals occur depends critically on how livelihood and land management decisions are affected by asset poverty, broadly defined to include limited endowments of all types of capital (Pender et al. 2004c). If increasing poverty causes poorer land management, then downward or upward spirals may occur, whereas if poor people manage their land as well as or better than wealthier ones, then such spirals are less likely (Pender et al. 2004c). Upward or downward spirals of land degradation are examples of path-dependent processes that are caused by positive reinforcement mechanisms (Arthur 1988). If such positive reinforcement does not occur (e.g., if poor people manage land as well as or better than wealthier ones), or if other factors outweigh any positive reinforcement that occurs (e.g., if improvements in technologies or access to markets lead to reduced poverty and land degradation), then downward spirals may not occur. Thus, it is necessary to assess the impacts of asset poverty and other factors on livelihoods and

land management in order to assess whether such downward spirals can occur and how they can be prevented or reversed.

The empirical studies in this book are mostly based on cross-sectional data and thus are limited in their ability to assess such dynamic issues as whether downward spirals of land degradation and poverty are occurring and what can be done about them. But by investigating the factors influencing households' livelihood and land management decisions at a given time, including various dimensions of poverty, these studies shed light on some of the issues influencing such dynamic processes. Furthermore, the databases and findings of this research provide a foundation on which future studies of the dynamics of poverty and land degradation can be built.

Income Strategies

Many factors affect outcomes such as agricultural productivity, household income, and land degradation. The central focus of this book is on the determinants and results of people's decisions about income strategies and land management practices. We define *income strategies* as the set of activities that households pursue to produce or acquire income and consumption goods, such as subsistence production of food crops, production of perishable cash crops, livestock production, forestry, and nonfarm activities.[1]

We hypothesize that such strategies have important direct implications for the outcomes of interest, and also affect them indirectly by influencing technology adoption and land management decisions. For example, production of high-value horticultural crops or other cash crops may lead to higher household incomes than production of food crops simply because the profitability of such crops may be greater than that from food crops. But they may also promote greater productivity, land improvement, and increased income indirectly by promoting greater use of purchased inputs, labor, or adoption of labor or capital intensive land improvements because higher value production increases the value of these inputs and the ability to finance them (e.g., Tiffen, Mortimore, and Gichuki 1994; Barrett, Place, and Aboud 2002).

Land Management

Agricultural production and land conditions are affected by land management practices, including both private decisions made by farm households and collective decisions made by groups of farmers and communities. For example, farm households make decisions about land use (whether, for example, cropland or grazing land), the crop types to plant, the amount of labor to use, and the types and amounts of inputs, investments, and agronomic practices to use to conserve soil and water, improve soil fertility, reduce pest losses, and so on. Communities also can influence

land management through their collective decisions. They may make investments on communal land areas (e.g., erosion controls on degraded lands, tree planting) or private lands (e.g., drainage investments as part of watershed conservation and development efforts) or regulate use of communal land (e.g., restrictions on use of grazing areas) or private lands (e.g., bylaws limiting burning or cutting of trees). As argued above, these household and collective decisions affect current agricultural production and income and affect the condition of land resources, thus influencing potential future agricultural production and income.

Determinants of Income Strategies and Land Management

Income strategies and land management decisions are affected by many different factors operating at different scales. These include factors that influence the relative profitability and hence comparative advantage of different income strategies and land management practices in a particular location, such as biophysical factors determining agricultural potential, population density, and access to markets and infrastructure (Pender, Place, and Ehui 1999; Pender, Scherr, and Durón 2001). These factors largely determine the comparative advantage of a location by affecting the costs and risks of producing different commodities, the costs and constraints to marketing, local commodity and factor prices, and the opportunities and returns to alternative activities, such as farming versus nonfarm employment. These factors may have generalized effects at the village or higher level on income strategies and land management, such as through their influence on local prices of commodities or inputs, or they may affect household-level factors such as average farm size.

Another important factor influencing income strategies and land management is access to programs and services, such as government or nongovernmental organization (NGO) technical assistance and micro–finance institutions, education and health services, and so on. Some of these programs and services, such as access to technical assistance and education, can affect local comparative advantages by increasing access to technologies and information, thus expanding households' available production and marketing possibilities. These and other programs and services also influence household constraints that affect income strategies and land management, such as limited access to finance and production inputs or labor constraints related to the health status of individuals.

Local institutions also have important influences on income strategies and land management. In much of the East African highlands, customary land tenure institutions determine what land use rights and land management obligations farmers have, how secure those rights are, whether those rights may be transferred or used as collateral, how conflicts are resolved, and other questions. Such institutions can have substantial effects on land management by regulating land use and land

management decisions, by facilitating or inhibiting collective action, and by affecting households' incentive and ability to invest in land management practices (Feder et al. 1988; Place and Hazell 1993; Platteau 1996; Otsuka and Place 2001a; Meinzen-Dick et al. 2002; Nkonya et al. 2005a). They may also influence (and be influenced by) households' income strategies. For example, local institutions may limit certain types of extractive activities such as timber cutting in forests, brick making in wetlands, or extensive livestock grazing. But these institutions may also change in response to new income-earning opportunities and relative factor scarcities (Boserup 1965; Hayami and Ruttan 1985; North 1990; Platteau 1996).

Although local institutions can evolve in response to changes in economic opportunities and scarcities, they are also largely affected by history and cultural factors and preferences; thus, institutional change may be path-dependent and resistant to change in many circumstances (North 1990). For example, historical changes in property rights in Ethiopia and Eritrea have not always occurred according to the predictions of the economic theory of property rights (Joireman 2001). In some cases changes were driven by outside influences (e.g., by feudal lords in southern Ethiopia and Italian colonists in Eritrea) rather than being endogenous responses to changing factor scarcities, whereas in other regions of Ethiopia (e.g., in Shoa province) the property rights system was resilient against change despite large changes in land scarcity. Besides differences in cultural factors, the power and interests of local political elites are also important determinants of whether and how changes in such local institutions occur (Joireman 2001). Platteau (1996) documents numerous cases throughout Africa in which the evolutionary theory of property rights fails to explain the nature of change in property rights systems.

Culture is also an important determinant of local consumption preferences and uses of factors of production. If markets are imperfect, production decisions are not separable from consumption preferences (Singh, Squire, and Strauss 1986; de Janvry, Fafchamps, and Sadoulet 1991); as a result, preference of a particular community for a certain type of staple food (e.g., *teff* in the Ethiopian highlands or *matooke* in central Uganda) may greatly affect the agricultural production system. For example, the prevalence of religious fasting periods in Ethiopia, during which individuals do not consume meat or dairy products, greatly influences the prospects for commercial livestock production for the domestic market. Similarly, religious prohibitions against consumption of pork by Muslims and Orthodox Christians limits the opportunities for pig production, and the large number of religious holidays celebrated by Orthodox Christians in Ethiopia (e.g., more than 100 days per year when agricultural work is prohibited; REST 1995), together with requirements that adults contribute 20 days of labor per year to mass mobilization labor

campaigns, may have a large influence on households' income strategies and land management decisions.

Household-level factors such as households' endowments of physical assets (e.g., livestock and equipment), "human capital" (assets embodied in people's knowledge and abilities, such as education, experience, and training), "social capital" (assets embodied in social relationships, such as through participation in organizations or informal networks), "financial capital" (access to liquid assets, including credit and savings), and natural capital (assets embodied in natural resources, including the quantity and quality of land, access to other resources) may also determine the income strategy and land management practices pursued by particular households. For example, education and access to financial and social capital may be critical in determining households' ability to take advantage of remunerative nonfarm opportunities (Barrett, Reardon, and Webb 2001), although these advantages may have mixed impacts on farmers' land management decisions, facilitating use of capital inputs but possibly undermining use of labor inputs by increasing the opportunity cost of labor (Reardon, Crawford, and Kelly 1994; Clay, Reardon, and Kangasniemi 1998; Pender and Kerr 1998). We discuss these and other hypotheses about impacts of specific factors further in the next section.

Government Policies, Programs, and Institutions

Government policies, programs, and institutions at many levels may influence income strategies and land management and their implications for production, resource conditions, and household income. Macroeconomic, trade, and market-liberalization policies will affect the relative prices of commodities and inputs in general throughout a nation. Agricultural research policies affect the types of technologies that are available and suitable to farmers in a particular agro-ecological region. Infrastructure development, agricultural extension, conservation technical assistance programs, land tenure policies, and rural credit and savings programs affect awareness, opportunities, and constraints at the village or household level. Policies or programs may seek to promote particular income strategies (e.g., nontraditional export cash crop production) or may seek to address constraints arising within a given income strategy (e.g., credit needs arising in cash crop production). Programs may attempt to address land management approaches directly, for example, by promoting particular soil fertility management practices. Policies and programs may also be designed to affect development outcomes directly, for example, through direct management of land by the government, or through nutrition or cash-transfer programs.

The opportunities and constraints for changes in policies are of course influenced by the political context, which can vary greatly from one location or temporal

context to another. The examples of the different policy environments and approaches cited in Chapter 1 illustrate this point, but different political contexts can lead to different policy "spaces" even within the same country and time frame. For example, decentralization policies in Ethiopia have provided differential autonomy for regional governments to respond to local perspectives in designing and implementing environmental policies and agricultural programs, with greater autonomy allowed in the Tigray Region than in the Southern Nations, Nationalities and People's Region (SNNPR) (Keeley and Scoones 2003). As with other contextual factors, such as culture and local histories, the local political context may lead to different responses and outcomes, even in areas that are otherwise similar in terms of natural endowments, access to markets, population pressure, and other socioeconomic conditions.

Currently available information does not provide policy makers with much guidance as to which of these intervention points will be most effective in achieving better land management, increasing agricultural production, ensuring sustainable use of resources, and increasing incomes and welfare. Much public action aimed at improving land management focuses on influencing household adoption of particular technologies. Yet this may be ineffective if the technologies are not suited to the income strategies that have potential in a given location, or it may miss opportunities for achieving larger impacts by focusing on other areas of intervention. Furthermore, the trade-offs or complementarities of different interventions in their impacts on development outcomes need to be assessed. This conceptual framework serves as a basis for addressing these information gaps through the studies in this book.

Hypotheses

The central hypothesis of the research reported in this book is that appropriate strategies for sustainable rural development and land management depend on the comparative advantages that exist for people in a particular location.[2] For example, opportunities for development of high-value perishable commodities, such as horticultural crops or dairy, are likely to be greatest in areas with relatively high market access and favorable agricultural potential. In such areas, investments in appropriate forms of market infrastructure and institutions may yield high social returns and facilitate a process of sustainable development. In areas more remote from markets or having lower agricultural potential, alternative income strategies, such as extensive livestock production or forestry, may have a greater comparative advantage, and development strategies addressing these livelihoods (e.g., promotion of improved institutions of common property resource management) are more likely to be effective.

We hypothesize that different income strategies and land management practices are affected by differences in comparative advantage and that these are largely determined by differences in agricultural potential, access to markets, infrastructure (e.g., roads, electricity, communication), and population density. Population density indicates the relative endowment of land and labor (the two primary factors determining production of agriculture in the East African highlands), and these, together with the agricultural potential in a particular location and available technology, determine the agricultural production possibilities. Access to markets and infrastructure, together with factor endowments and agricultural potential, largely determines the local relative prices of inputs and outputs, which determine farmers' comparative advantages in choice of outputs and inputs, as explained in further detail below. The comparative advantage of pursuing nonagricultural versus agricultural livelihoods is also largely affected by households' access to markets and potential for agricultural production. Other factors, such as access to new technologies via technical assistance, access to credit, education, land tenure, household wealth, and others, can also influence livelihoods and land management practices by affecting the information that farmers have access to and the constraints that they face, irrespective of local comparative advantages.

Agricultural Potential

Agricultural potential is an abstraction of many factors, including rainfall, altitude, soil type and depth, topography, access to irrigation, presence of pests and diseases, and others, that influence the absolute (as opposed to comparative) advantage of producing agricultural commodities in a particular place. There are, of course, variations in potential depending on which commodities are being considered. Furthermore, agricultural potential is not a static concept but changes over time in response to changing natural conditions (such as climate change) as well as human-induced conditions (such as land degradation). Throughout this section, we discuss agricultural potential and other multidimensional concepts such as market access in a simplified heuristic fashion to help define the generic set of hypotheses for empirical research, recognizing that there can be complex implications of variations in the component dimensions of these concepts that we will not be able to fully illuminate.

If all markets were perfect and transactions were costless, farmers' production choices would be based on maximizing profits from current production and on maximizing the net present value of investments (Singh, Squire, and Strauss 1986; de Janvry, Fafchamps, and Sadoulet 1991). In such a scenario (unrealistic as it is), choices about agricultural production and land management would depend only on exogenous prices and biophysical factors determining agricultural potential,

which together would determine the profitability of alternative agricultural decisions. Other factors would be important in determining prices, but these would not vary across households in the context of perfect markets. Thus, variations in agro-ecological conditions would be the primary determinant of variations across households and locations in agricultural decisions.

In the perfect markets case, one would expect all land to be allocated to its most profitable uses. Because different agro-ecological conditions are suitable for different types of commodities, we would expect different income strategies to be favored in different conditions. For example, perennial crops such as coffee and bananas generally grow better in higher bimodal rainfall areas. On the other hand, some annual crops, such as many cereals and cotton, grow better in less humid environments with a single long growing period. This suggests that perennial crops are likely to be found in the more humid bimodal rainfall zones and that many annual crops would be found in drier unimodal rainfall zones. However, these choices also depend on prices: if prices of cereals were high enough, they might be grown throughout East Africa.

In areas of generally higher agricultural potential, such as in highland areas having favorable rainfall and fertile volcanic soils, we would expect the highest-value commodities, such as horticultural crops, tea, and coffee, to be produced. Lower-value commodities such as cereals are more likely to be grown in areas of lower potential, along with complementary livestock production (McIntire, Bourzat, and Pingali 1992). Extensive livestock grazing is likely to be found in lower-rainfall areas not well suited to continuous crop production. In a more realistic market context, production of some of these high-value commodities, particularly perishable vegetables and fruits, may be inhibited by limited access to markets and infrastructure, and food crops may need to be grown in areas of low market access to satisfy subsistence requirements regardless of profitability (Omamo 1998).

If insurance markets are missing or imperfect, agro-ecological conditions may also influence income strategies by affecting risks (Binswanger and McIntire 1987). For example, households may seek to diversify their income sources and crops as a means of coping with production or price uncertainty (Binswanger and McIntire 1987; Ellis 2000; Barrett, Reardon, and Webb 2001). Such considerations may lead to greater diversification or to adoption of less profitable but less risky crops in areas where rainfall is more uncertain, as in drought-prone areas. Risks of pests and diseases also could lead to similar risk-management strategies.

Agro-ecological conditions also influence labor intensity and land management practices. In general, higher agricultural potential is expected to be associated with higher labor intensity and adoption of more labor and input-intensive practices, by increasing the marginal return and/or reducing the risks of these inputs (Barrett

et al. 2002). For example, fertilizer use is likely to be less profitable and more risky in low-rainfall areas because nutrient uptake may be limited by inadequate soil moisture. Higher-rainfall areas may be associated with greater adoption of vegetative land management practices such as use of agroforestry, live barriers, and mulching because of higher biomass productivity in such areas. By contrast, adoption of some soil and water conservation measures may be more profitable and less risky in low-rainfall areas because they may have a larger impact on yields in the short run by conserving scarce soil moisture and may be less prone to harboring pests and weeds than in high-rainfall environments (Herweg 1993a,b).

The impacts of more favorable agro-ecological conditions on crop production and incomes are expected to be positive. Higher agricultural potential is expected to promote more intensive and productive use of inputs and production of higher-value crops as noted above, leading to higher value of crop production and income. Livestock incomes may be higher in such areas because of greater availability of feed sources. On the other hand, farmers in high-potential areas may have less comparative advantage in livestock production because of higher profitability of crop production and because problems of animal pests and diseases are generally greater in more humid environments. Nonfarm opportunities linked to agricultural production are likely to be greater in higher-potential areas (Haggblade, Hazell, and Brown 1989; Reardon 1997; Barrett, Reardon, and Webb 2001), although households may be less prone to pursue such opportunities given the higher profitability of farming in these areas. Overall, we expect household incomes to be higher in higher-potential environments, controlling for differences in access to land and other resources.

The expected impacts of agricultural potential on land degradation are mixed. In higher-potential areas, there is likely to be more planting of perennial crops and more vegetative cover of the soil in general, which helps to limit soil erosion. However, the higher rainfall in such areas may be more erosive, especially in steeply sloping areas such as in the highlands. Soil nutrient depletion may be higher in such areas as a result of greater offtake of biomass from fields, especially if use of fertilizer or other means of soil fertility restoration is limited. Thus, some aspects of land degradation may be worse in higher-potential zones, even if other aspects are better.

Access to Markets and Infrastructure

Access to markets and infrastructure is critical for determining the comparative advantage of a given location, given its agricultural potential. For example, a community with an absolute advantage in producing perishable vegetables (i.e., total factor productivity in vegetable production is higher there than anywhere else) may

have little or no comparative advantage (low profitability) in vegetable production if it is far from roads and urban markets. As with agricultural potential, market access is also a multidimensional and dynamic concept (e.g., distance to roads, condition of roads, distance to urban centers, access to foreign markets, degree of competition, access to transport facilities).

Because of the substantial transaction costs of storing, transporting, and marketing commodities, access to markets and roads is critical for determining the comparative advantage of a particular location, given its agricultural potential. Following von Thünen (1826), we postulate that land will be allocated to its highest-rent use, which in areas close to urban markets is more likely to be in production of intensive high-value commodities that involve substantial transport costs (such as vegetables and dairy products) or used for industrial purposes than in production of lower-value and more transportable food grains or livestock using extensive methods or natural forest (Chomitz and Gray 1996).[3] Even if high-value crops are more profitable than food commodities further from markets, farmers faced with high transport costs may need to produce low-value crops for their subsistence purposes rather than higher-value cash crops (Omamo 1998; Key, Saudolet, and de Janvry 2000).

In areas of high market and road access, production of perishable high-value crops such as horticultural crops is likely to be profitable if agro-ecological conditions are suitable. These may displace other, less perishable and profitable cash crops such as coffee to areas somewhat more remote from markets because such crops can be transported over greater distances at lower costs than perishable commodities. Other bulky food crops may also have a comparative advantage close to urban areas, given their high transport costs, or be grown for subsistence purposes in more remote areas. More storable and transportable crops, such as cereals and legumes, are likely to have a comparative advantage further from markets and roads because they can be stored and transported over longer distances than other commodities.

Dairy production and other intensive livestock operations are also more likely to be found close to urban areas because of economies of scale in production and marketing, high transport costs, perishability of the products (e.g., limited viability of milk), and the need for market access to purchased compound feeds. Extensive production of livestock that are relatively easy to transport, such as cattle and small ruminants, can occur in areas far from markets and is likely to have a comparative advantage in areas that are low in potential for crop production.

Opportunities for rural nonfarm activities are also likely to be greater closer to urban markets and roads (Haggblade, Hazell, and Brown 1989; Reardon 1997; Barrett, Reardon, and Webb 2001). This includes activities linked to agriculture, such as processing agricultural commodities, commodity trading, and provision of agri-

cultural inputs as well as other activities stimulated by higher demand resulting from higher incomes in areas of better access. Employment opportunities in urban industries are also likely to be greater for people who live closer to urban centers.

Better access to markets and roads is expected to increase the use of purchased inputs and the capital intensity of agriculture by increasing the profitability and availability of such inputs and increasing farmers' access to credit (Binswanger and McIntire 1987). However, the effects of market and road access on labor intensity and land management are ambiguous. For example, the level of commodity prices has a theoretically ambiguous influence on soil conservation investments (LaFrance 1992; Pagiola 1996). Higher access implies that the marginal return from labor invested in crop production and land management is higher (because output and land prices are increased) (Binswanger and McIntire 1987), but the opportunity costs of labor are also likely to be higher. The net result depends on which effect is stronger (Barbier and Bergeron 2001). The positive effect of market and road access on input use may have further influences on use of labor-intensive practices, depending on whether capital- and labor-intensive practices are complements or substitutes.

The effects of market and road access on the value of crop production are also ambiguous. To the extent that better access promotes production of higher-value crops, increases the local prices of crops, and promotes more intensive use of inputs, it tends to increase the value of crop production. However, as mentioned above, better access also may reduce the labor intensity of crop production and thus could reduce the value of output.

Given the ambiguous effects of market and road access on land management, the effects on land degradation are also, not surprisingly, ambiguous. By increasing the profitability of agricultural production, greater market access will promote expansion of production into forest areas or other fragile lands if the costs of productive factors and output prices are unaffected by market access (Angelsen 1999), which will increase land degradation in such areas. However, if the costs of factors rise because of constrained supply or prices fall as a result of inelastic demand, a reduction in agricultural area (and hence the pressure on forests and other fragile lands) is possible as productive factors are concentrated on the most profitable lands (Angelsen 1999). Market-driven intensification may also contribute to land degradation by leading to reduced fallowing (Binswanger and McIntire 1987), which will contribute to declining soil fertility and increased erosion (from reduced vegetative cover) unless sufficiently offset by adoption of more intensive soil fertility management and soil conservation practices. Improved market access may contribute to increased use of animal draft power for tillage (Binswanger and McIntire 1987), which may contribute to soil erosion on sloping lands. Commercialization of

agricultural commodities also can contribute to depletion of soil nutrients if the nutrients being exported from the farming system in the form of commodity sales are not adequately replenished by fertilizers or other nutrient sources (de Jager, Nandwa, and Okoth 1998). On the other hand, market-driven intensification may lead to reduced erosion and improved soil fertility management as a result of the increased incentive to invest in land improvements, given the rising value of land relative to labor (Tiffen, Mortimore, and Gichuki 1994).

Regardless of its net influence on crop production, better market and road access is expected to have a positive effect on income because access increases households' income earning opportunities, whether through increased agricultural production or through nonfarm activities.

Irrigation

Irrigation is a form of infrastructure that directly affects agricultural potential. As with improvements in market access, irrigation investment can enable production of higher-value crops such as horticultural crops. It likely contributes to labor intensity by enabling multiple crops per year to be produced and by increasing the return and/or reducing the risk of labor invested in crop production. If this intensification increases the costs of productive factors (e.g., if wages rise as a result of increased labor demand), irrigation may limit expansion of agricultural production, as in the case of improved market access. Irrigation may promote investments in complementary soil and water conservation investments and practices, such as investments in soil bunds and drainage (Pender and Kerr 1998). It may also encourage farmers to adopt complementary productive inputs such as fertilizer, particularly where soil moisture constraints limit farmers' willingness to use fertilizer (Pender, Place, and Ehui 1999). As a result of these effects, irrigation is likely to contribute to increased value of crop production and incomes.

The effects of irrigation on land degradation may be mixed. Irrigation increases the incentive to invest in land improvement and soil fertility management by increasing the value of such investments. On the other hand, irrigation may contribute to problems of soil erosion or salinity if runoff and drainage are not managed adequately. Irrigation can also contribute to increased soil nutrient mining by increasing production and commercialization of crops unless adequate efforts are made to replenish such nutrients. Irrigation also may have negative effects on people downstream as a result of reduced access to water or increased use of agrochemicals.

Population Pressure

Population pressure (indicated by higher population density) affects the expansion of agriculture and the labor intensity of agriculture by affecting the land/labor

ratio. It may cause households to expand agricultural production into areas less suited to agriculture, contributing to lower agricultural productivity and natural resource degradation, as argued two centuries ago by Thomas Malthus and more recently by his modern followers (e.g., World Commission on Environment and Development 1987). But population pressure may cause households to intensify their use of labor and other inputs on the land and may also induce innovations in technology, markets, and institutions or investments in infrastructure, thus possibly mitigating or outweighing such negative Malthusian effects (Boserup 1965; Ruthenberg 1980; Hayami and Ruttan 1985; Binswanger and McIntire 1987; Tiffen, Mortimore, and Gichuki 1994).

Population pressure is expected to increase labor intensity in agriculture by increasing the availability (hence reducing the costs) of labor relative to land (Boserup 1965). Higher labor intensity of agriculture can take the form of production on more marginal lands, less use of fallow, adoption of more labor-intensive methods of cultivation, labor-intensive investments in land improvement, and/or adoption of more labor-intensive commodities (e.g., horticultural crops and intensive livestock production) (Pender 2001). Income strategies that are land and resource intensive, such as forestry and extensive livestock production, are likely to be less viable in more densely populated settings. There may be greater opportunities for rural nonfarm activities in more densely populated settings because of larger markets and lower transaction costs, which will facilitate diversification of economic activities (Tiffen, Mortimore, and Gichuki 1994).

Population pressure may also induce increases in the capital intensity of agriculture if capital is complementary to labor (e.g., use of draft animals; McIntire, Bourzat, and Pingali 1992) or increase the "knowledge intensity" of agriculture through adoption or adaptation of technologies (e.g., improved seeds, integrated pest or soil nutrient management). It may also have more indirect (but still important) effects by stimulating migration, investments in infrastructure, or technical or institutional change (Pender 2001).

Population-induced intensification is likely to lead to higher yields and higher value of crop production per hectare unless greater intensity is offset by land degradation (Salehi-Isfahani 1988; Pender 2001). However, labor intensification may lead to lower labor productivity and per capita income (as a result of diminishing returns to labor) unless offset by technical change, improvement in infrastructure and market access, or other improvements in opportunities (Binswanger and McIntire 1987; Salehi-Isfahani 1988; Pender 2001).

The impacts of population pressure on land degradation may be mixed. Land degradation may increase as a result of cultivation on fragile lands, reduced use of fallow, increased tillage, mining of soil nutrients, and other potential results of

agricultural expansion and intensification, consistent with Malthusian predictions. On the other hand, more labor-intensive investments in land improvements and soil fertility management practices as a consequence of lower wages relative to land values resulting from population pressure may improve land conditions, consistent with Boserup (Scherr and Hazell 1994; Tiffen, Mortimore, and Gichuki 1994; Pender 2001). Considering these issues, some have argued that there may be a U-shaped response of natural resource conditions as rural population increases, with initial degradation followed by improvement as population and resource degradation reach a point at which it becomes profitable to invest in conserving and improving resources (Scherr and Hazell 1994; Pender 1998; Otsuka and Place 2001a). However, such favorable responses may not be automatic (even if investments in resources become profitable), as they depend on the existence or development of a favorable institutional environment for investment (e.g., secure and individualized property rights) (Scherr and Hazell 1994; Pender 1998; Otsuka and Place 2001a).

Development Domains

These factors (agricultural potential, market access, and population pressure) interact with each other in complex ways. Population density tends to be higher where there is greater agricultural potential or greater market access because people have moved to such areas in search of better opportunities. On the other hand, population pressure may have contributed to land degradation, reducing agricultural potential from what it once was. Market access tends to be better where there is a higher population density because the per capita costs of building roads are lower and the benefits higher in such circumstances. Market access also tends to be better where agricultural potential is higher because the returns to developing infrastructure are greater.

Some of these relationships can contribute to self-reinforcing patterns of development. For example, population growth in a region increases the size of the local market and hence the profitability of local industry and agriculture (where economies of scale or transport advantages are involved), thus leading to increased local wages and further population growth through immigration (Krugman 1998). On the other hand, some of these relationships may cause offsetting tendencies. For example, population growth may lead to land degradation, which increases production costs and undermines the potential for intensifying agriculture, even as the demand for local agricultural production increases.

Despite these interrelationships, there is still substantial independent variation of these factors in the East African highlands. Given such variations, and the fact

that most of these factors change relatively slowly over time, it is useful to consider different development domains represented by variations in these variables. Overlaying the indicators used in Figures 1.2, 1.3, and 1.4, we represent one possible classification of development domains in East Africa in Figure 2.2 (see color insert).

The potentials for different income strategies, land management practices, and the effects of policies influencing these decisions are likely to vary across such domains (Pender, Place, and Ehui 1999). For example, commercialization of high-value perishable crops such as fruits and vegetables may be highly profitable and feasible in areas of high agricultural potential and favorable market access (which are also usually densely populated), such as highland areas close to major urban centers in central Kenya and Ethiopia (Table 2.1). Dairy production and other intensive livestock production also are likely to be profitable in such regions because of the demand for milk and meat in urban areas, its high perishability and transport costs, and availability of feed supplies. High-value, but less perishable, crops such as coffee and tea and lower-value food crops also can be produced in areas of high potential and market access, though the profitability of many of these crops may be lower than that of high-value perishable commodities in these areas. Rural

Table 2.1 Hypotheses about income strategies in different development domains in the East African highlands

Agricultural potential	Market access: High	Market access: Medium/low
High	Central Kenya, Uganda, and Ethiopia near urban centers Perishable cash crops Dairy, intensive livestock Nonperishable cash crops Intensive food crop production Rural nonfarm development	Southwestern Ethiopia, western Kenya, southwestern and eastern Uganda Nonperishable cash crops Intensive food crop production Livestock production (especially in areas of moderate population density)
Low	Parts of northern/eastern Ethiopia near urban centers With irrigation investment: Intensive food crop production Perishable cash crops Dairy, intensive livestock Without irrigation investment: Low-external-input cereals Rural nonfarm development	Much of northern and eastern Ethiopia With irrigation investment: Intensive food crop production Without irrigation investment: Low-external-input cereals Extensive livestock production (in areas of low population density) Woodlots/forestry/beekeeping (especially in low-density areas) Emigration

Source: Adapted from Pender, Place, and Ehui (1999).

nonfarm development, linked to agricultural production through development of input supply and agricultural processing industries and demand linkages for rural services, also may have strong prospects in high-potential, high-access areas.

Areas with high agricultural potential but less favorable market access, such as significant parts of the highlands of southwestern Ethiopia, western Kenya, and eastern and southwestern Uganda, likely have a comparative advantage in producing high-value (relative to their volume) nonperishable commodities (such as coffee) that can be transported over relatively long distances. Given the high costs and risks of depending on imported food in such areas, farmers may continue producing most of their own food crops until improvements in roads and transportation services, as well as increased production of food crops in other regions, allow imported food to be more economical and less risky. At this stage of development, complementary linkages between crop and livestock production are important, with animals providing a source of draft power, manure, and food protein, and crop residues an important source of feed (McIntire, Bourzat, and Pingali 1992). Thus, opportunities for livestock production linked to crop production are also likely to be important, particularly in areas of low or moderate population density with sufficient available land to provide fodder. There is likely to be good potential for adoption of purchased inputs in such areas, financed by sales of cash crops or livestock, as a way to improve local food supplies as well as income.

In lower-potential areas, such as the moisture-stressed highlands of northern and eastern Ethiopia, adoption of input-intensive food crop production may be risky and of limited profitability in rainfed conditions. Where irrigation and good market access are available, intensive production of food and cash crops is likely to be profitable. Increased production of cereals and fodder in irrigated areas may also facilitate intensive dairy or other livestock production in areas close to cities. In nonirrigated low-potential areas, the agricultural options are more limited. Soil and water conservation investments may yield significant returns in moisture-stressed areas and may facilitate targeted and limited use of fertilizer and other inputs where soil moisture is adequate. Where population density is high and farms are very small, farmers in such low-potential environments may be unable to produce sufficient surplus to finance purchase of inputs. Thus, this will be most feasible closer to urban areas where nonfarm sources of income are available, where rural industries are developing, or where seasonal migration (or remittances from permanent migrants) is common.

In more remote low-potential areas with low population density, improvement of extensive livestock production may offer development potential. Achieving this potential may require the strengthening of collective action institutions to encourage investments in improvements of grazing lands, perhaps by planting and managing fodder grasses and trees. Tree planting and related activities, such as

beekeeping, may also provide opportunities for significant incomes and welfare improvement, especially where market access is relatively good.

The most difficult cases in terms of viable income strategies are areas with low agricultural potential, without irrigation, that are far from markets and are densely populated (as in parts of the northern Ethiopian highlands). In some cases, particularly in less densely populated areas close to forests, forestry and beekeeping activities can be important. Where natural forests have been depleted or are protected, tree planting may be profitable. Small ruminants can be efficient users of available fodder resources and can be transported long distances to market, though intensification of their use will be limited by availability of fodder or grazing materials. Rehabilitation of degraded lands, investment in soil and water conservation structures, and low-external-input methods of soil fertility enhancement also may have significant potential to improve land productivity. Nevertheless, these seem unlikely to solve the long-term poverty problem facing such communities. Emigration (short or long term) is likely to be an important element of the livelihood strategy for many households in these areas.

Income Strategies

Income strategies influence land management and labor intensity. For example, production of high-value horticultural crops or other cash crops will promote greater use of purchased inputs, labor, and adoption of labor-intensive land improvements such as terraces because higher-value production increases the value of these inputs and the ability to finance them (e.g., Tiffen, Mortimore, and Gichuki 1994; Barrett et al. 2002). Mixed crop–livestock producers are more likely to apply manure to their crops because they have greater access to this bulky resource. When credit is constrained, households with greater access to off-farm income may be more prone to use inputs or make investments that require cash, such as fertilizer or hired labor (Reardon, Crawford, and Kelly 1994; Clay, Reardon, and Kangasniemi 1998; Pender and Kerr 1998; Reardon et al. 2001). On the other hand, households with greater off-farm opportunities may be less prone than others to invest labor in crop production or labor-intensive land management practices because their opportunity costs of labor may be higher (if labor markets are imperfect) (Scherr and Hazell 1994; Pender and Kerr 1998).

By influencing crop choice and the intensity of input use, income strategies affect the value of agricultural production. For example, the value of crop production is expected to be higher for producers of high-value crops than other producers. Income strategies may also affect the value of agricultural production by affecting the ability of households to produce and market their commodities. For example, households that specialize in production of certain crops may develop better ability

to produce and market their crops than those that are more diversified. Livestock producers may obtain better crop production because of deposition of animal manure on their fields (even if they are not investing effort in collecting and applying manure). Households involved in nonfarm activities may have advantages in liquidity and risk management that enable them to obtain better prices for their crops (e.g., by not being forced to sell right at harvest).

Income strategies may also have impacts on land degradation. For example, households producing higher value crops or having nonfarm income may be more likely to replenish soil fertility by using fertilizer, or may invest more (or less) in soil and water conservation measures, as argued above. The impacts on land degradation will depend on the net effects of decisions affecting crop choice, input use, and land management practices.

Income strategies are also expected to affect household incomes and poverty. Households able to rely on high-value crops, intensive livestock systems, or remunerative nonfarm activities are likely to earn higher incomes than those confined to subsistence food crop production (Tiffen, Mortimore, and Gichuki 1994; Barrett, Reardon, and Webb 2001). On the other hand, households dependent on low-wage off-farm employment may be poorer than even subsistence farm households.

Access to Programs and Services

As noted earlier, access to programs and services can influence the income strategies and land management practices of communities and households by affecting their access to information about technologies, their capacities to effectively use technologies or to organize collective action, and their financial or other constraints. In this subsection, we consider three types of programs and organizations that are expected to have significant influence on income strategies and land management: technical assistance programs and organizations, credit and microfinance programs and organizations, and educational services.

Technical assistance programs and organizations. Because natural resource management (NRM) technologies are knowledge-intensive (Barrett et al. 2002), technical assistance is likely to be an important determinant of their adoption. Presence of programs and organizations is likely to improve delivery of NRM technologies (Swinkels and Franzel 1997). However, the effects of participation in programs and organizations will likely depend on their focus.

Credit. Credit programs may enable farmers to purchase inputs or acquire physical capital, thus contributing to technology adoption and increased capital and

input intensity in agriculture (Feder, Just, and Zilberman 1985). This may promote increased production and marketing of high-value crops or intensification of livestock production and a reduction of subsistence food crop production. If credit availability helps to relax capital constraints, this can reduce the extent to which households discount the future (Pender 1996; Holden, Shiferaw, and Wik 1998), possibly leading to more investment in soil and water conservation (Pender and Kerr 1998). Credit may also facilitate labor hiring and thus promote labor intensification. On the other hand, credit availability may enable households to invest in nonfarm activities and may thus contribute to less intensive management of land and other agricultural resources. Also, by promoting intensification of capital and purchased inputs, credit may reduce labor-intensive land management practices that are substitutes for these (e.g., fertilizer use may reduce use of manure and compost). The net effects of credit on land management, crop production, and land degradation are thus ambiguous. The impact of credit availability on income is likely to be positive, provided households have profitable uses for it (otherwise the effect may be nil or even negative).

Education. Education is likely to increase households' opportunities for salary employment off farm and may increase their ability to start up various nonfarm activities (Barrett, Reardon, and Webb 2001; Deininger and Okidi 2001). Education may increase households' access to credit as well as their cash income, thus helping to finance purchases of physical capital and purchased inputs. This may help to promote production of high-value crops and intensive livestock production as well as promoting greater use of such capital and inputs in producing traditional food crops. Education may also promote changes in income strategies and technologies by increasing households' access to information about alternative market opportunities and technologies, and hence households' ability to adapt to new opportunities (Feder, Just, and Zilberman 1985). On the other hand, more educated households may be less likely to invest in inputs or labor-intensive land investments and management practices because the opportunity costs of their labor and capital may be increased by education. Thus, the net impacts of education on land management, crop production, and land degradation are ambiguous. The impact on household income is expected to be positive.

Property Rights and Land Tenure

Property rights and the form of land tenure can affect land management and productivity for several reasons. If there is insecurity of tenure, the household operating the plot may have less incentive to invest in land improvement (Feder et al.

1988). This is not necessarily the case, however, if the household can increase tenure security by investing in the land (Besley 1995; Otsuka and Place 2001b). In that case, there may be more investment on land having insecure tenure.

Perhaps more important for land management than security of tenure is the set of rights associated with the different tenure systems. Owners of freehold land have complete rights to use, lease, sell, bequeath, and mortgage their land. Owners or occupants of lands under other tenure systems may have more restricted rights, including restrictions on sales, leasing, and mortgaging. These restrictions may reduce farmers' access to credit, where land is (or could be) used as collateral for credit (Feder et al. 1988; Place and Hazell 1993). If so, farmers having more complete property rights (such as ownership under freehold tenure) may be more prone than other farmers to use cash inputs or make investments. The effects of this would be similar to the effects of increased access to credit discussed above. Also, to the extent that land sales or lease rights enable households to recoup the value of land improvements, owners with more complete transfer rights may be more likely to make investments in land improvement (Pender and Kerr 1999; Deininger et al. 2003).

Ownership of a formal title may amplify the impacts of greater tenure security and complete land rights associated with freehold by providing proof of freehold status. In particular, formal title may facilitate access to credit and help to prevent or resolve land disputes (Feder et al. 1988). However, whether land titles have the hypothesized positive impacts on tenure security, credit access, and investment in the African context has been much debated in the literature (Shipton 1988; Haugerud 1989; Atwood 1990; Barrows and Roth 1990; Migot-Adholla et al. 1991; Place and Hazell 1993; Bruce and Migot-Adholla 1994; Besley 1995; Platteau 1996; Sjaastad and Bromley 1997; Nkonya et al. 2004). Limited or adverse impacts of land titles on security and investment in Africa may be caused by many factors, including adequate security of customary tenure, rent-seeking opportunities created by titling efforts, limited availability of rural credit regardless of whether land is usable as collateral, limited ability to foreclose on mortgaged land, use of collateral substitutes by credit organizations, lack of updating of titles following sales or land subdivision because of high costs, or other factors.

In addition to tenure status and land title, the means of acquisition of land may also influence farmers' tenure security and incentives to invest in land management. For example, tenants on rented or borrowed land are unlikely to invest in soil and water conservation measures or in perennial crops if the lease or borrowing arrangement is relatively short term, regardless of the tenure system under which the landholder claims the land. Tenants on sharecropped plots may have less incentive to apply labor and other inputs than owner-operators or tenants using fixed rental (Shaban 1987; Otsuka and Hayami 1988). By contrast, owners of purchased

land and tenants using cash rental may have more incentive than owners of inherited land to produce cash crops and apply inputs in order to be able to recoup the costs of their investment and repay any loans used to finance the investment. Land users who have encroached on public or communal lands may face substantial tenure insecurity; and this may prevent them from undertaking investments or fallowing unless such investments are perceived as increasing the land user's tenure security (Otsuka and Place 2001a).

Household Endowments

If factor markets (markets for land, labor, and capital) do not function efficiently, then there may be significant differences among households in their land management practices and agricultural productivity (de Janvry, Fafchamps, and Sadoulet 1991). In the context of imperfect labor and land markets, agricultural households with less land or a larger family labor endowment per unit of land can be expected to use labor more intensively in agricultural production (Feder, Just, and Zilberman 1985). Essentially, the impacts of smaller farm size, or larger household labor endowment controlling for farm size, will be similar to the effects of population density if imperfections in labor or land markets limit the extent to which differences in labor endowments can be overcome through labor or land transactions. Greater labor availability per unit of land may also induce households facing land constraints to pursue alternative off-farm income strategies, such as wage employment and various nonfarm activities. The effect of smaller farm size or larger family size on the value of crop production per hectare is likely to be positive if labor and land markets are imperfect, or zero if these markets function well. The impact of labor availability on household income is expected to be positive (as long as the marginal product of labor is positive), though the impact on income per capita may not be (if there are diminishing returns to labor). As with population pressure, the impact of labor availability on land degradation is ambiguous.

If credit is constrained, farmers who own more livestock, equipment, or other physical assets may be better able to finance the purchase of inputs or investments, either by liquidating assets or through better access to credit. The impacts on crop choice, land management, and labor intensity are thus qualitatively similar to the impacts of access to credit discussed above and are ambiguous for the same reasons.

The impact of livestock on land degradation may be mixed and depends on the type of degradation as well as on interactions between crops and livestock. Livestock may contribute to soil compaction and erosion along animal walkways, and if draft animals are used for tillage, they also may contribute to erosion and compaction as a result of tillage operations. Livestock usually have a more positive role in plant nutrient cycling at the household level. If farmers apply animal manure to

their crop plots, then it is likely that farmers with more animals would have higher nutrient balances than those with fewer animals. However, farmers may fail to apply manure or other organic materials to their crop plots for various reasons. Farmers often keep animals close to the homestead, which implies greater availability of manure close to the homestead. This, together with the difficulty of transporting manure because of its bulkiness, implies that plots further away from the homestead are less likely to receive manure and other bulky organic materials such as household wastes. Thus, we expect plots away from the residence to have lower nutrient balances than those closer.

Farm equipment may also have mixed effects on land degradation. Plows and other machinery may contribute to soil erosion through tillage, especially if used on sloping lands. On the other hand, equipment may be used to help construct soil and water conservation structures or to apply fertilizer or other inputs that help to prevent soil erosion, nutrient depletion, or other forms of degradation.

The effect of livestock and other physical assets on household income is expected to be positive, to the extent that such assets are accumulated for purposes of increasing income. However, there may be other reasons for accumulating assets. For example, livestock may be kept as a store of relatively liquid wealth and as an insurance substitute, where financial and insurance markets are poorly developed because of problems of covariate risk (Binswanger and McIntire 1987). Livestock, jewelry, or other assets also may be accumulated for dowry or bequest purposes. Thus, the impacts of some physical assets on income may be limited.

Summary of Hypotheses

The hypotheses are summarized in Table 2.2. In general, most factors have theoretically ambiguous impacts on agricultural production, land management, and land degradation. Many factors have more unambiguous expected impacts on household incomes. These hypotheses suggest that the impacts of policy and program interventions on agricultural production and land degradation may be very context specific, and may often involve trade-offs among the objectives of increasing agricultural production, reducing land degradation and increasing household incomes. Empirical research is essential to understand these impacts and trade-offs, given the theoretically ambiguous nature of most of these relationships.

In the remainder of this book, we present 13 case studies from Ethiopia, Kenya, and Uganda that investigate many of these empirical relationships using a variety of data sources and analytical methods. Many studies use econometric approaches to investigate the effects of different factors on land management and outcomes, controlling for confounding influences. Some of these studies are based on community

Table 2.2 Summary of hypotheses

Impacts of	Livelihood strategy	Labor intensity	Land management practices	Value of agricultural production	Land degradation	Income
Higher agricultural potential	+ Higher-value crops – Lower-value crops – Extensive livestock +/– Intensive livestock +/– Nonfarm activities	+	+ Labor- or capital-intensive practices + Agroforestry, vegetative methods – Some SWC measures	+	+/–	+
Higher market/road access	+ Perishable cash crops – Storable crops – Subsistence food crops + Intensive livestock – Extensive livestock + Nonfarm activities	+/–	+ Capital- and input-intensive practices +/– Labor-intensive practices	+/–	+/–	+/0
Higher population density	+ Labor-intensive activities (food crops, horticulture, intensive livestock) – Land-intensive activities (extensive livestock, forestry) + Nonfarm activities	+	– Land-intensive practices (fallow, slash and burn) + Labor-intensive practices +/– Capital- and input-intensive practices	+/0	+/–	0/–
Livelihood strategy (cf. subsistence food crops)	NA					
– High-value crops		+	+ Labor- and capital-intensive practices	+	+/–	+
– Livestock		+/–	+ Use of manure	+/–	+/–	+
– Nonfarm activities		+/–	+ Purchased inputs, hired labor	+/–	+/–	+/–
Irrigation	+ Horticultural crops	+	+ Practices complementary to irrigation and horticultural crops (e.g., fertilizer use)	+	+/–	+

(*continued*)

Table 2.2 (continued)

Impacts of	Livelihood strategy	Labor intensity	Land management practices	Value of agricultural production	Land degradation	Income
Programs and organizations	? Depends on focus	?	?	?	?	?
Credit	+ Capital- and input-intensive strategies (high-value crops, intensive livestock, nonfarm) – Subsistence food crops	+/–	+ Purchased inputs and capital (if credit used for agriculture) +/– Labor-intensive practices	+/– (depends on whether used for agriculture)	+/–	+/0
Education	+ Salary employment + Nonfarm activities +/0 High-value crops and intensive livestock	+/–	+ New technologies + Capital- and input-intensive practices +/– Labor-intensive practices	+/–	+/–	+
Larger household labor endowment or smaller farm size	+/0 Labor-intensive activities (food crops, horticulture, intensive livestock) –/0 Land-intensive activities (extensive livestock, forestry) +/0 Nonfarm activities	+/0	–/0 Land-intensive practices (fallow, slash and burn) +/0 Labor-intensive practices +/– Capital- and input-intensive practices	+/0	+/–	0/+ (labor) – (smaller farm size)
Livestock ownership	+ Livestock activities + Complementary cropping activities (e.g., cereals)	+/–	+ Capital-intensive practices +/– Labor-intensive practices	+/–	+/–	+/0
Farm equipment ownership	+ Capital-intensive agricultural activities	+/–	+ Capital-intensive practices +/– Labor-intensive practices	+/–	+/–	+
Land tenure security/more complete land rights (e.g., freehold versus others, titled versus not, owner versus not)	+/– Perennial crops +/0 Capital- and input-intensive commodities	+/–	+/– Land investments +/0 Capital- and input-intensive practices +/– Labor-intensive practices	+/–	+/–	+/–

or other meso-level data, whereas others use household and plot survey data. As mentioned previously, most of the studies are based on cross-sectional data, limiting their ability to draw conclusions about dynamic processes of change, although a few of the case studies address dynamic issues using historical recall information. In the fourth part of the book, reviews of results of experimental studies and farm level work in the three study countries are used to assess the influences of land management on agricultural productivity and other outcomes, and two other studies use bioeconomic models to enhance understanding of the driving forces and dynamics of changes in land management and outcomes and the potentials for improvement in land management and incomes as a result of policy and program options. In the final chapter, we draw conclusions and policy implications from this wide ranging set of empirical studies.

Notes

1. This definition is similar to the concept used by Reardon and Vosti (1995). Ellis (2000, p. 40) defined livelihood strategies similarly as the "activities that generate the means of household survival." According to Ellis, this definition includes natural resource–based activities, such as collection of natural resource products (e.g., forestry or fishing), cultivation of food or nonfood commodities, livestock rearing, and nonfarm natural resource–based activities (e.g., mining); and non–natural resource–based activities and sources of income (e.g., rural trade, services, manufacturing, remittances, and other transfers) (Ellis 2000). Other authors have provided somewhat broader definitions of livelihood strategies. For example, Adato and Meinzen-Dick (2002, p. 10) define people's livelihood strategies as "the choices they employ in pursuit of income, security, well-being, and other productive and reproductive goals." Although land management decisions could be seen as part of households' livelihood strategies, we wish to investigate the relationships between the major decisions that households make about how to earn their income (such as in agriculture vs. nonfarm activities) and land management decisions. Thus, we use the narrower term *income strategies* to distinguish this concept from the concept of land management.

2. Comparative advantage refers to the profitability of the economic activities that a group of people may pursue, relative to other activities that could be pursued by that group (Stiglitz 1993, p. 61). Having a comparative advantage in a given activity does not imply that the group earns more profit from the activity than could other groups (that would be absolute advantage); rather, it means that the group profits more by pursuing that activity than other activities and by trading with others who have comparative advantage in pursuing other activities. Comparative advantage can be defined for groups of different sizes at different scales (e.g., nation, region, community, household, individual), though it is most commonly discussed at a national scale in discussions of trade theory and policy.

3. As did von Thünen, we take the location of urban markets as predetermined. Recent theoretical developments in economic geography have sought to explain the location and growth of cities based on consideration of plant-level economies of scale, transport costs, positive externalities, or other sources of economies of agglomeration (e.g., Krugman 1998). Consideration of these theories and their implications is beyond the scope of this book.