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ABBREVIATIONS

AFC	Agriculture Finance Corporation
DDE	Dairy Development Enterprise
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GOK	Government of Kenya
ICRAF	International Centre for Research in Agro-Forestry
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
KCC	Kenya Cooperative Creameries
KTDA	Kenya Tea Development Agency
NCPB	National Cereals and Produce Board
NGOs	Non Governmental Organizations
SAP	Structural Adjustment Programme

SUSTAINABLE AGRICULTURAL DEVELOPMENT IN KENYA: *POTENTIAL STRATEGIES*

ABSTRACT

Low agricultural productivity, land degradation and poverty are severe interrelated problems in the East African highlands. While the proximate causes of such problems are relatively well known, the underlying causes are many and complex, and depend upon many site-specific factors that vary greatly across the diverse circumstances of the region. Thus, no "one-size-fits-all" policy, institutional or technology strategy is likely to suffice to generate sustainable development. While common elements of successful strategies do exist, such as security and macroeconomic stability, the appropriate portfolio of investments in physical, human, natural and social capital will likely be different in different circumstances.

In this paper, i argue that the appropriate strategy for sustainable development depends greatly upon the "pathways of development" that are feasible in a given location.

Development pathways represent common patterns of change in economic livelihood strategies, such as continued semi-subsistence mixed crop-livestock production or commercialization of high-value perishable crops. I argue that such development pathways will be largely determined by three factors determining comparative advantage: agricultural potential, access to markets, and population density. Based on a typology of situations in the East African highlands using these variables, I develop hypotheses about the potential pathways of development in different situations, and the policy and institutional requisites to achieve sustainable development of such pathways. I also argue that the choice of development pathway largely conditions the opportunities for particular resource management technologies, and develop hypotheses about the technological strategies that may be feasible within particular development pathways.

I conclude the paper with hypotheses about the priorities for policy intervention to achieve sustainable development in the East African highlands. Among these, I suggest that the highest priority for road and irrigation development should be areas close to urban markets with high agricultural potential; that development of input and output markets and credit systems will be most critical in such areas; that increasing food security through increased food crop production or other means is likely to be a key to realizing the potential for more commercial production; that subsidies on the costs of transporting fertilizer to remote, high-potential, food deficit areas should be considered as a lower cost alternative to food aid; and that intensified and more private use of hillsides and grazing areas for sustainable uses such as tree planting may have potential to achieve more rapid and sustainable development of lower potential areas. I emphasize that these are only hypotheses, and that policy research is needed to assess their validity in different contexts of the East African highlands

1.0 **INTRODUCTION**

In Sub-Saharan Africa, the nexus of population pressure, low and declining agricultural productivity, and unsustainable use of natural resources threatens a downward spiral of increasing poverty and land degradation unless effective strategies to reverse the spiral are identified and implemented. Cleaver and Schreiber (1994). These problems are particularly severe in the East African highlands. Average population density is more than 1 person per hectare in the highlands and well over 2 persons per hectare in many areas. Most farm households attempt to subsist on less than 1 hectare of land and incomes of much less than $1 per day. Cereal yields are well below yields attained in other parts of the world (averaging little more than 1 tonne per hectare for most cereals), while yield growth has been slow or in some cases, declining over the past several decades. Hoeckstra and Corbett (1995). Livestock productivity is also low compared to other parts of the world. For example, milk yields are less than 4 liters per day in the highlands Winrock International (1992). These trends are all the more distressing because agricultural potential is quite high in much of the East African highlands, with sufficient rainfall and suitable soils to support much more intensive and profitable agriculture than currently exists.

The proximate causes of these problems are well known. Bojo and Cassells (1995); Sanchez et al. (1997): increased cultivation on steep slopes, inadequate vegetative cover on croplands, deforestation, overgrazing, burning of crop residues and dung for fuel, low use of inorganic fertilizers or integrated nutrient management, declining use of fallow, and limited adoption of soil and water conservation measures. Underlying these proximate causes are many more fundamental factors, including population growth, poverty, insecure land tenure, limited access to markets and credit, risks associated with the use of inputs and new technologies, and limited farmer knowledge of appropriate technologies in some cases. Government policies and institutions affect most of these causes. For example, market liberalization, credit policies, input supply policies and infrastructure investment have a large impact on opportunities to use inorganic fertilizers Bumb and Banaante (1996). Land tenure policies may affect security of tenure, land. fragmentation, and access to credit, and hence affect incentives and ability to invest in land improvements or to use inputs. Place and Hazell (1993). Education affects population growth and poverty. Education, research and extension policies can affect farmer knowledge about specific natural resource problems (e.g., types of nutrients required) and appropriate technologies to address such problems.

Given the complexity of factors influencing land degradation and the diversity of situations existing in the Kenyan highlands, no single package of technologies will be able to address all of the problems. Similarly, no "one-size-fits-all" policy strategy will suffice to generate sustainable development, although there will be common elements to successful strategies in all cases, including macroeconomic stability, a competitive market environment, land tenure security, and investments in physical, human, natural and social capital. Much of what distinguishes different strategies will be differences in the portfolio of such investments that are needed in different circumstances.

The objectives of this paper are to begin to identify such strategies, to suggest what kinds of strategies are appropriate for different types of situations, and to consider the policy and institutional requisites for these strategies to be successful. The suggestions will be offered as hypotheses rather than as firm conclusions, since substantial empirical research is still needed to investigate the feasibility and desirability of the suggested strategies and supporting policy and institutional interventions.

In this paper, i argue that the nature of land degradation problems and appropriate means of addressing them will depend upon the broader development pathway that is pursued. For example, in areas where commercial crop production is occurring, the potential to address soil nutrient depletion using large inputs of inorganic fertilizer will be much greater than where production is likely to remain mainly subsistence-oriented. The latter situation will require lower use of external inputs, although opportunities for integrating small amounts of purchased inputs with local sources of inputs should not be overlooked.

I also argue that the policy and institutional strategy, particularly the appropriate mix of public and private investments, should be linked to the pathway of development. For example, areas where a commercialization pathway is viable may require development of input and output markets through private or public investment in transportation and marketing facilities, credit, etc. Appropriately targeted and sustained research and technical assistance will be important to all strategies, but especially where a low external input (and knowledge intensive) pathway is pursued.

The appropriate development pathway depends upon the factors that determine local comparative advantage. Three factors of particular importance in this regard are agricultural potential, population density, and access to markets. Accordingly, i consider development pathways suitable to different circumstances along these three dimensions, and present examples from the highlands of Kenya. In the next two sections i present a brief overview of the agricultural context and the policy environment in each of these three countries. In section 4, i consider possible development pathways for different situations and in section 5, i consider the policy and institutional strategies to facilitate such pathways. In section 6, we offer tentative policy conclusions and directions for further research

1.1 AGRICULTURE IN KENYA

The Kenyan highlands stretch from the eastern slopes of Mt. Elgon southward through Nyanza province to the Tanzanian border and eastward through a narrow section of the rift valley and then expanding once more to cover the Aberdere range, Mount Kenya, and environs to the south and east. In total, the highlands cover approximately 18 percent of the land area. The highlands generally include the better agricultural areas and as a consequence population densities are high. It is estimated that 64 percent of Kenya's population resides in this relatively small area and many local areas have population densities in excess of 1,000 inhabitants per square kilometer. Braun et al. (1997). Most highland areas enjoy two rainy seasons, the long season from March to June and the short

rainy season from October to December. Average annual rainfall is generally over 1,200 mm with much higher amounts reported in the higher elevations near Mount Kenya. The climate in the western highlands is warm year round with average temperatures of 21 o C. In the higher elevation central highlands, temperatures are somewhat cooler, with average high temperatures reaching as low as 18 o C in certain months of the year.

Soils throughout the highlands are generally deep, well drained, clay-loams and are considered of medium to high agricultural potential. Nitisols dominate in the central highlands and are derived from volcanic rock. The central highlands are characterized by moderate to steep sloping land and thus there is a need for soil conservation measures to ensure continued productivity of soils. As discussed in more detail below, there are not widespread problems of soil infertility in the central highlands due to the commercial nature of agriculture and farmer reinvestment in land. In western Kenya, there is a major problem of nutrient depletion in the otherwise high-potential ferralsols, acrisols, and nitisols. For example, phosphorus has been found to be severely depleted (Olson P levels below 5 ppm) in widespread soil testing. ICRAF (1997). In addition, some of the soils are high phosphorus fixing, implying that much of the phosphorus in the soil is not available to plants. Sanchez et al. (1997). Nitrogen is another major limiting nutrient and potassium deficiencies are also reported. These are not inherent characteristics of the soils, but rather a result of many decades of continuous cropping and nutrient export with little nutrient input.

Throughout most of the highlands, land registration and consolidation exercises had taken place in the 1960s. In central Kenya, the results of this were single-parcel farms of between 3 and 8 hectares. In the sloping areas, these normally stretched from a ridge down a slope to a bottom valley area. After a generation or so of land subdivision, average farm sizes generally range from 1 to 4 hectares. Relative to other rural areas, this region generates high agricultural income and households are able to educate their children, many of whom take up jobs in the non-agricultural sector, partially easing the pressure for land subdivision. The updating of titles following transfers of land is commonly practiced in this area relative to the western highlands. Place and Migot-Adholla (1998). In the western highlands, farms are more or less the same size, with the exception that in some of the most densely populated areas, farm sizes of below 1 hectare are common. In both areas, the most common form of land acquisition is through inheritance. Some purchasing of land takes place, but renting of land, though growing in significance, has not traditionally been important. In both areas, there is much off-farm activity as some family members will seek employment in the major cities.

Two important distinctions between the western and central highlands are the higher elevation and closer proximity to Nairobi (and the shipping port) of the central highlands. The higher elevation has permitted the productive cultivation of perennials such as coffee and tea, and the proximity to Nairobi has provided a ready market for cash activities such as dairy production. In the central highlands there is consequently a wide range of both cash and food crops grown. The major cash crops are tea (in the higher elevations), coffee, miraa (a stimulant), macademia nuts, fruit trees such as avocado, and vegetables. The major food crops are maize, beans, irish potatoes, bananas and an assortment of

vegetables. In addition, livestock production, mainly for milk, is extremely important and in most areas over 80 percent of households own cattle. Minae et al. (1988). Consequently, sizeable land area is devoted to production of fodder, such as napier grass. Murithi (1998).

Farmers market coffee and tea through cooperatives, the local tea and coffee societies, and their widespread establishment has facilitated expansion of these commodities. The area under tea production has steadily increased to where Kenya is now the world's second largest exporter of tea. Coffee production remains an important provider of foreign exchange but production levels have been more volatile. Dairy has been a major growth industry both during the monopoly period of the Kenya Cooperative Creameries (KCC) and since the liberalization of the sector in the early 1990s. Horticulture is also important in the central highlands. Flowers are restricted to larger farmers but smallholders are engaged in pyrethrum, tobacco, french beans, macadamia, and other fruits and vegetables.

One of the benefits of the cooperatives was to provide credit for inputs and sometimes other investments. This meant that as long as output prices were attractive, farmers normally had the interest and capacity to apply fertilizer inputs to their cash crops. For coffee, for instance, Kenyan farmers normally add nutrient inputs, as opposed to farmers in Uganda. The access to credit also had spillover effects into other crops and investments such as education. Thus, one of the features of the central highlands is the development of a highly diversified and intensified agricultural system. There remain poor households, but opportunities to improve livelihoods through agriculture abound. The case of western Kenya is different. There are only isolated areas suitable for production of cash crops such as coffee or sugarcane. There is a sizeable regional demand from a large rural population and the presence of several small cities, but the distance to the largest cities and key tourist areas is relatively long and transport costs high. As a result, in comparison with the central highlands, the profitability of agriculture has traditionally been lower and farmers have in turn reinvested very little in agriculture. The general description is of low-input semi-subsistence farming systems. Maize and bean systems dominate, but in some areas bananas are common and in others sorghum and millet can be found. There is also some growing of cassava and sweet potato.

The higher valued crops in the system are the vegetables such as French bean, kale, cabbage, onion, pepper, and tomato. Tea is grown in some parts of the western highlands, though not as common as in the central highlands. Livestock (particularly crossbreeds) are also not as common as in the central highlands, and are normally confined to the wealthier households who utilize them for milk, manure, and sometimes ploughing. Yields of most crops are low and households normally must buy additional food to supplement production. In addition, acute demands for cash, for education fees for example, force households into selling food crops at low prices following harvest and buying them later at much higher prices. Western Kenya is a net importer of food

2.0 POLICIES AND INSITUTIONS AFFECTING AGRICULTURE DEVELOPMENT IN KENYA

Here i consider the effects of recent changes in the policy environment on development in the Kenyan highlands, and the major policy and institutional constraints that still appear to inhibit development potential

The Government of Kenya implemented a structural adjustment program beginning in 1986 and elements of this program are still being carried out such as the privatization of state enterprises. The reforms have targeted both macro-economic areas as well as sectoral areas, including agriculture. The government relaxed foreign exchange regulations and by 1995, the private sector could move currencies relatively freely. Tariff rates were reduced on many goods and the import/export sectors were freed up from excessive licensing restrictions. The shilling was allowed to be market determined (with the typical stabilization influence by the central bank) and interest rates were also freed to market forces. After the elections in 1992, the government ceased the printing of money to finance government shortfalls and was forced into meeting imbalances through borrowing. Following this, inflation has increasingly been under control, averaging at or below 10 percent since 1996. Real interest rates, on the other hand, increased dramatically as the government had to pay high interest rates in order to raise the significant amount of funds it required. Much of the government debt was held by commercial banks which tended to choke off domestic private lending. The high real interest rates attracted foreign funds and this helped to maintain a strong shilling over this time (1995-1999). The recent macro-economic indicators have generally been well received by the World Bank and IMF.

The government has had difficulty in funding its planned public expenditure program. Government revenues have almost annually been disappointing with much evasion of tax. When the IMF also withdrew its financing mechanism, the government has had to respond by reducing expenditures. This has meant that infrastructure revitalization and development has been slowed. The El Niño rains of 1997-98 further damaged the poor infrastructure. Funds for agricultural research and extension have also been tight, and have relied to a large extent on donor support. The government has reduced costs by retrenchment in some ministries and in parastatals. The Kenya Revenue Authority has also recently been given more latitude to collect taxes and in 1998 tax collections actually exceeded target levels. The government has also introduced cost- sharing mechanisms in many sectors such as education and health.

In agriculture, important policy areas include inputs, credit, output, research and extension, land tenure, and land management. The agricultural input sector in Kenya has been one of the bright spots. Even prior to SAP, Kenya had abandoned subsidies for fertilizers and other inputs. Following liberalization, the government has slowly allowed competition in the sector to grow. The fertilizer sector, though already quite competitive relative to other countries in Africa, was decontrolled in 1990 and the number of importers and distributors has reached 23 by 1997. Nyoro (1999). In response, the number of types of fertilizer on the market has increased four-fold. The seed sector also

involves several major firms that compete with the Kenya Seed Company. The government has long had an interest in increasing the availability of credit to farmers. State supported credit is channeled through the Agricultural Finance Corporation (AFC), the Coffee Marketing Board, and the Kenya Tea Development Authority. The AFC though does not lend to smallholder farmers (a farmer must have at least 5 hectares of land). As in Ethiopia, lending to the livestock sector is constrained in Kenya. For example, Freeman et al. (1998b) found that a 1-percent increase in credit for purchasing crossbred dairy cows leads to 1.6 percent increase in milk productivity on credit constrained farms and 0.9 percent increase in productivity on non-constrained farms.

Private financial institutions rarely lend for agricultural purposes and when they do, only to large farmers with considerable collateral. Recent years have seen the launching of micro-finance projects, but only a few have targeted agriculture. Despite these mechnisms, it is estimated that only 10 percent of credit goes to agriculture while it contributes over 30 percent of GDP. Mwangi (1999).

There has been increased devolution of control and participation in the marketing of output by the state, but this has been a slow and rough process. Maize, the most important food crop has been largely freed from government regulation. Price supports and movement restrictions have disappeared. The National Cereal Produce Board (NCPB) still exists with the mandate to stockpile foodstuffs for national food security, but there is a thriving private sector that buys and sells maize throughout Kenya.

Moreover, the NCPB itself has become a commercial enterprise and has reduced staff by 65 percent between 1993-98. Mwangi (1999). The Kenyan government is still highly involved in the marketing of coffee, tea, sugar, and meat. Government parastatals are the sole buyer for tea and coffee, which are especially important in the highlands. Producer prices generally follow world prices and therefore Kenyan coffee farmers have not been spared the shocks of volatile world coffee prices. Production of coffee fluctuates widely in response to prices and as well to the speed of payment by the coffee board, which has often been slow in the past. The Kenya Tea Development Authority, on the other hand, has performed relatively well and tea area has continued to expand among smallholders in Kenya. For both coffee and tea, marketing outlets are well distributed through key growing areas in the highlands. The dairy sector had been tightly controlled by the Kenya government through the mid-1990s, when restrictions of selling milk to the parastatal, Kenya Co-operative Creameries (KCC), were eased. KCC now buys a small share of total milk production and is in negotiation with a foreign firm to form a joint venture. The state still has strong influence on prices and incentives for some crops through their import policies, which in the case of maize, sugar, and wheat remain politically influenced.

Research, extension, and other agricultural information services in Kenya, while not up to the resource levels of Asian countries, compare favorably with other African countries. Agricultural research has a legacy of emphasizing cash crops for the larger farmers, but the Kenya Agricultural Research Institute has now decentralized into many locations to focus on the particular needs of smallholder farmers in those areas. Kenya has pursued

the Training and Visit approach to extension and this has had poor results in some areas due to low extension worker to farmer ratios and limited transport resources. The government, however, is a supporter of new approaches and has facilitated the introduction of the catchment approach for soil conservation and the many innovative methods used by an array of NGOs.

Land tenure is largely secure for rural households and this is particularly the case in the highlands. Thus, farmers' willingness to invest is not hampered by uncertainty of land rights. The government has also spearheaded efforts to promote sustainable agriculture through the establishment of the permanent presidential commission on soil conservation and afforestation. In response, production and distribution of tree seed and seedlings was actively promoted and farmers throughout the highlands continue to plant trees for various purposes. The Ministry of Agriculture embarked on an ambitious soil conservation program in the late 1970s and the National Soil and Water Conservation. Program is recognized globally as one of the most successful conservation program, now reaching 100,000 farmers per year.

Kenya has long adopted a strategy to increase local level planning. Thus, sectoral plans are developed with inputs from district level plans. While this decentralization has been in place for some time, unlike in Uganda and Ethiopia, there has not been much movement towards actual devolution of power. The executive branch retains most political power and continues to make appointments at local administrative levels and it these appointments who provide most of the inputs into local planning. The state had, until 1996, also appointed the directors of the Kenya Farmers Association. The executive branch also develops strategic plans for the country. Recognizing the continued high rural population growth rates and continuing miniaturization of farms, the government has set a goal of becoming a semi-industrialized nation within the next few decades. There will be considerable obstacles in meeting this challenge, and widening the tax base to ease rates of taxation and interest will be among the first tasks. Public investments in transport, energy, and communication infrastructure will also be required. There will be keen competition for scarce funds from both the urban and rural sectors, most notably in social programs for education and health

2.1 STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Over the past decade, a consensus has begun to emerge about many common features required for successful development strategies in Africa, most of them following standard neoclassical prescriptions. Delgado (1995; World Bank (1994); Cleaver and Schreiber (1994). General peace and security are needed to allow a climate favorable to production and investment. Macroeconomic policies that ensure a low and stable inflation rate are needed to reduce risks and allow development of the financial system. Foreign exchange and trade policies should be liberalized to avoid a bias against tradable goods. Competition should be allowed to develop in domestic markets to promote efficient allocation of scarce resources.

Although this consensus is very helpful in encouraging governments to stop doing things that have had negative impacts on development (such as foreign exchange and domestic price controls), it is less helpful in providing guidance to governments on what they should do. A useful general principle to guide government action is to undertake those actions that yield high social net returns and that would not be done as well by some other means in the absence of government action. According to this principle, governments should intervene mainly to provide public goods (goods such as research or rural roads whose benefits are largely non rival and non excludable, and hence not adequately provided by private markets); to address other market failures such as externalities (such as caused by environmental pollution or water use), missing markets (such as absence of credit and savings markets), and imperfect competition (such as monopoly power); or to address equity considerations such as problems of deep seated poverty.

To move from this general principle to specific actions, it is helpful to think of different pathways of development that may be appropriate in different circumstances. As mentioned in the introduction, the appropriate pathway of development depends upon current and potential comparative advantage. The returns to alternative policy and technology strategies in different locations will depend upon the potential comparative advantages. For example, investments in research and extension linked to adoption of improved cereal varieties and heavy use of inorganic fertilizer are likely to yield much higher returns where rainfall is relatively assured than in drought-prone areas where use of such inputs can be very risky. Highly labor intensive methods of soil and water conservation, such as building terraces or composting, are more likely to be adopted in more densely populated and less commercialized areas, where the opportunity cost of labor is low. Adoption of animal traction technologies is likely to yield higher returns in areas with heavy clay soils than in areas with light, erodible soils. Strategies relying on heavy use of purchased inputs and credit are unlikely to be successful in remote areas where high transport and marketing costs make subsistence agriculture the dominant development pathway, even if they are able to cause substantial improvements in productivity. Similarly, commercial dairy production is likely to develop in peri-urban areas but not in remote areas.

Many factors combine to determine comparative advantage and the appropriate response to it. We will focus on three factors that i believe are critical: agricultural potential, access to markets, and population pressure. Agricultural potential is an abstraction of many factors—including rainfall, altitude, soil type and depth, topography, 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 upon 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). For simplicity of exposition, however, we will sweep aside these important considerations and discuss agricultural potential as though it was a one dimensional and fixed concept. In reality, the multi-

dimensional and dynamic nature of agricultural potential should be considered when developing more specific strategies of development than will be possible in this paper. Access to markets 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 multi-dimensional and dynamic concept (distance to roads, condition of roads, distance to urban centers, degree of competition, access to transport facilities, etc.), but we will treat it as a single predetermined variable (though subject to change through investments in roads, for example).

Population pressure affects the labor intensity of agriculture by affecting the land/labor ratio, and may also induce innovations in technology, markets and institutions, or investments in infrastructure. Boserup (1965); Ruthenberg (1980); Hayami and Ruttan (1985); Binswanger and McIntire (1987). Population pressure thus affects the comparative advantage of labor intensive pathways of development, as well as returns to various types of investments. We take average population density as an indicator of population pressure, although one could argue that population density per unit of arable land would be a better indicator. Absence of comparable data on this latter indicator makes it difficult to use in practice, however. To some extent, differences in agricultural potential will account for differences in arable land per total area of land (i.e., the fraction of arable land is likely lower in areas with lower agricultural potential, controlling for population density).

These three factors interact with each other in complex ways. Population density tends to be higher where there is greater agricultural potential or greater market access, since 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 higher population density, since 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, since the returns to developing infrastructure are greater.

Despite these interrelationships, there is still substantial independent variation of these factors in the East African highlands. Given such variations, and the fact that these factors change relatively slowly over time, it is useful to consider how different combinations of these factors influence possible development pathways. i can classify the situations of the East African highlands into a maximum of eight types, considering "high" and "low" levels of each dimension. I recognize that there is an unavoidable element of arbitrariness in defining these terms. "High agricultural potential" refers to areas with more than 1,000 mm of annual rainfall, at medium altitude (less than 3,000 m elevation), and with soils suitable for agricultural production with minimum investment (excluding very thin soils, vertisols, highly acidic soils, and those which are high P-fixing). This includes most of the highlands of Uganda and Kenya, and most of the High-

Potential Perennial and High-Potential Cereals zones of Ethiopia. "High market access" refers to areas relatively close to an urban center and with access to an all-weather road and transport facilities. Although relative to other parts of Africa, population density is high in all of the highlands, we consider "high" population density to mean greater than 175 persons per square kilometer. This includes most of the highlands of Kenya and southwestern Uganda, and some of the highlands of Ethiopia. Braun et al. (1997).

Areas with high agricultural potential but low market access have more of a comparative advantage in producing high-value (relative to their volume) non-perishable commodities (such as coffee or tea) that can be transported over relatively long distances. Given the high costs and risks of depending on imported food into such areas, farmers are likely to 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 et al. (1992). Thus, intensified livestock production may be beneficial as well, particularly in lower population density areas with more available land to provide fodder. There is good potential for adoption of purchased inputs, financed by sales of cash crops or livestock, as a way to improve local food supplies as well as income. This can result from use of inputs on both types of crops, and by freeing up land and labor from food crop production for cash crop production. However, where perennial cash crop production is not yet well established or not very profitable (but potential exists), the need for subsistence food production may undermine the ability to take advantage of such cash crop potential.

There may be potential to build upon the soil and water conservation investments being made in moisture-stressed areas, by promoting targeted and limited use of fertilizer and improved seeds to the parts of the fields where soil moisture is greatest. However, such a limited and adaptive approach is not presently being pursued. For this approach to be economically feasible, sources of income to finance input purchases are needed. Where population density is high, farms in such low-potential environments are unlikely to be able to produce sufficient surplus to finance purchase of inputs. Thus this will be most feasible closer to urban areas where off-farm sources of income are available, where rural industries such as mining are developing, or where seasonal migration (or remittances from permanent migrants) is common. In vertisol areas, as in many parts of central Ethiopia, increased food crop production depends upon investments to address the problems of drainage and waterlogging. While technologies have recently been developed to address these problems (such as the broad bed maker), adoption is not yet widespread. Gezehegn and Heidhues (1998). Factors inhibiting adoption of the broad bed maker include appear to include inadequate training in its appropriate use, limited availability of complementary inputs (especially seed and fertilizer), and low output/input price ratios resulting from removal of fertilizer subsidies and poor infrastructure (ibid.).

2.2 POLICY AND INSTITUTIONAL REQUISITES

The policy and institutional requirements of sustainable development will depend upon which development pathways are pursued. Here i consider some of the critical constraints affecting the pathways discussed in the previous section, and the policy and institutional requisites to address these constraints. I also consider some of the implications of these pathways for sustainable land management.

2.3 HIGH EXTERNAL INPUT INTENSIFICATION OF FOOD CROP PRODUCTION

The first requirement of this pathway is the availability of food crop varieties that will respond well to fertilizer and other inputs in the conditions of the Kenyan highlands.

To have the broadest and most sustainable economic impact, promotion of such technologies should account for local potentials and economic conditions as much as possible. As discussed previously, small farm sizes and uncertain rainfall (especially in moisture-stressed areas) can make allocation of half-hectare plots to new technologies a very risky strategy. This is less of a concern where rainfall is relatively assured or irrigation exists, but many farmers even in these circumstances still may prefer to adopt a more gradual or diversified approach, which may be precluded by a fixed package approach such as being promoted in Ethiopia. In addition, adaptive and participatory research is needed to develop more targeted recommendations for integrated nutrient management practices; taking into account available sources of organic matter, local sources of phosphate rock, and potential for leguminous crops or trees. Quinones et al. (1997); Sanchez et al. (1997). The priority for such research in the near term should be high-potential areas where this pathway is most feasible. For the longer term, continued basic research is needed to develop varieties that are suitable under lower potential conditions, such as in moisture-stressed environments or in acid soils.

Other positive efforts that can help develop such competitive markets include investments in road construction and improvement and facilitation of the availability of credit to private wholesalers and retailers to finance purchase of storage and marketing facilities and working capital stocks. In remote food deficit areas where substantial improvements in market access are not likely in the near future, consideration of the most effective means to address poverty and food security should include consideration of subsidizing the cost of transporting inputs to these areas (perhaps by continuing government provision to these areas). Since 1 ton of fertilizer can yield 3-7 tons of additional grain in higher potential areas. Mulat et al. (1997), it is much cheaper to subsidize the cost of transporting fertilizer than grain (through food aid) to such areas as a means of addressing food deficits. Subsidies are of course costly and difficult to maintain as a long-term strategy, but are a lower cost alternative to providing food aid to relatively high-potential, remote, food-deficit areas. There also can be difficulties in targeting subsidies, if farmers try to resell the fertilizer to other areas where fertilizer is not subsidized. This potential problem would be minimized, however, if the subsidy were

only on transport costs. The longer term solution for such areas is to invest in improved infrastructure and transport services, but people still must be able to feed themselves in the near term.

The high external input pathway may facilitate more sustainable land management. Investments in soil and water conservation will be more attractive to private farmers since the value of land and the need to minimize losses of valuable inputs through erosion and runoff will be increased. In addition to direct benefits where such intensification occurs, indirect benefits in other areas can also result, as increased supplies of biomass reduce pressure on forests and grazing areas, and increased incomes provide alternatives to expansion of production onto marginal lands.

The impacts of this strategy on restoring soil fertility are not assured however. Soil fertility can be restored through increased use of fertilizer together with greater production of organic material. However, a net increase in soil mining may occur even with greater use of fertilizer, as a result of increased losses through erosion, leaching and quantities harvested. For example, recent estimates from western Kenya show greater nutrient mining on farms where there was more commercial orientation in food crop production, suggesting that the profitability of using fertilizers in food crops may be insufficient to prevent such depletion. De Jager et al. (1998). Further research is needed on this issue.

In summary, to fully realize the potential benefits of a high external input strategy of increasing food production, adequate attention must be paid to factors affecting the feasibility and profitability of input use, including infrastructure, extension, input availability, credit, and marketing facilities. In some cases where persistent food deficits exist, subsidies on the costs of transporting inputs should be considered as a lower cost alternative to food aid, until these other constraints can be overcome. IFPRI (1995).

2.4 LOW EXTERNAL INPUT INTENSIFICATION OF FOOD CROP PRODUCTION

In lower potential areas without irrigation, the return to using external inputs, particularly fertilizer, is likely to be much more limited. The strategy for intensifying food crop production therefore must rely on a low (not zero) external input approach. In moisture stressed areas, a critical need is to conserve and use the available soil moisture as efficiently as possible, in combination with integrated use of limited amounts of inorganic fertilizer with organic nutrient sources.

Research is also needed to better understand the potential for improving soil productivity through integrated use of organic and inorganic fertilizers in different settings. Palm et al. (1997). Organic sources vary greatly in terms of their biomass productivity and nutrient content, their interactions with soil moisture and inorganic sources of nutrients, and their impacts on productivity; and these issues are not yet well understood in Sub-Saharan Africa (ibid.). For example, application of organic materials may reduce nutrient availability to crops by immobilizing nitrogen, especially if the ratio of carbon to nitrogen

in the organic materials is high. Organic materials can also increase pest problems. On the other hand, they may increase nutrient availability by reducing phosphorus fixation, and improve soil physical properties and water holding capacity. It is also important to recognize that many organic "sources" of nutrients (such as crop residues or manure produced from grazing crop residues) only recycle nutrients within the farming system, and do not add to the stock of nutrients in the system. As important as such recycling is to help slow the rate of nutrient depletion, it cannot restore soil fertility. Biological nitrogen fixation by leguminous plants, uptake by trees of nutrients that are unavailable to crops, and transfer of biomass from outside the farm do increase the stock of nutrients available to the farming system, and can be very important components of a low external input strategy. However, these strategies cannot adequately restore phosphorus where it is depleted. Sanchez et al. (1997). Thus, some use of inorganic fertilizer is an essential component of strategies to restore soil fertility and increase agricultural productivity, especially where phosphorus depletion is a major problem.

A critical constraint on increased use of organic material in low-potential areas is the shortage of such material and high demand to use it for other purposes (particularly in high population density areas) such as burning of dung and grazing of crop residues. It is thus difficult to address the soil fertility problem in such areas without addressing the larger problem of a shortage of biomass. One way to address this issue is to make better use of degraded lands and communal grazing areas to produce biomass. The key to success seems to be to provide the right set of incentives. The community approach to planting woodlots has yielded limited benefits in Kenya whereas allowing individuals to receive private benefits from tree planting (with secure tenure) shows promise of achieving impressive results.

The impact of these new policies remain to be seen, but if they do result in a substantial increase in tree planting and harvesting from wastelands, more manure and crop residues can be recycled into crop production as fuelwood becomes more available. As the general biomass shortage is reduced, the need for the most rapidly growing species (generally eucalyptus) will decline, and other kinds of trees, such as fruit trees, legumes, and fodder producing trees may become more attractive to plant. This will increase opportunities for improving soil fertility and intensifying livestock production, as well as generating income directly from tree products.

Improved management of pasture and grazing areas also could yield substantial benefits. For example, area enclosures are being used to allow regeneration of natural grasses and trees in many parts of the Ethiopian highlands. These are showing good results in terms of regeneration, but there are common complaints from farmers that they are not benefiting from the biomass being produced (where cut and carry or controlled grazing systems have not been established). In addition, enclosures tend to increase pressure on other unprotected areas, so the net impact on resource degradation is not necessarily positive. To help ensure that positive benefits are achieved and felt by farmers, more intensive management of grazing areas, such as planting and managing improved grasses and trees, is needed. This could be approached by allocating such lands for private grazing use or through better collective management of enclosures.

Because of economies of scale in protecting grazing areas and risk spreading advantages of using them collectively, privatization of such lands may not be optimal. Baland and Platteau (1996). However, attaining the benefits of collective management requires effective institutions at the local level. Such institutions do not necessarily arise spontaneously, even when the net benefits of effective collective action are large (ibid.). Government or other external intervention can help to catalyze the development of such institutions, though this requires a cautious approach that respects local autonomy and concerns. Heavy-handed intervention from external agents can undermine the development of such institutions, causing increased dependency on the regulatory role of such external agents, and possibly increased conflicts in the community. Research is needed to better understand the conditions under which effective institutions for managing grazing lands arise and become sustainable in the Kenyan highlands, and how governments and NGOs can help to promote rather than undermine this development. Where this does occur, intensified livestock production, improved soil fertility management, and increased incomes will also likely occur. Organic sources of crop nutrients can also be generated on cropland. Many practices have been developed for this purpose, such as hedgerow intercropping, improved fallows, green manures, composting, and planting of fodder or multi-purpose trees. Cooper et al. (1996). High population density and remoteness from markets favors more labor intensive practices (such as hedgerow intercropping or composting) since opportunity costs of labor are lower in such circumstances. ibid; Ehui et al. (1990). However, the potential of such approaches is limited by the scarcity of water in the low- potential highlands. High population density and small farm sizes will limit more extensive practices, such as improved fallows and planting trees. In land scarce settings, planting of trees may be most feasible in particular niches, such as in the homestead plot, on bunds and on plot boundaries. However, planting on boundaries and bunds can create problems by competing with crops for water and light on the owner's as well as neighbors' fields (ibid.).

Fragmentation may also prevent investments in land improvements such as planting fruit trees or constructing soil bunds, since these may be subject to theft or damage by neighbors if not easily supervised. For example, Olson (1995) reports cases of farmers in the Kabale district of southwestern Uganda surreptitiously undermining terraces on plots of their upstream neighbors, thus "harvesting" some of the fertile soil that had accumulated in the terrace. Restrictions on land sales and leasing, as exist in Ethiopia, contribute to the land fragmentation problem. However, the example from Uganda, where such restrictions do not exist, suggests that reform of land policies would not necessarily solve it.

Livestock grazing practices also can have a significant impact on the feasibility of some kinds of land improving investments. For example, free grazing on farmland after the harvest is common in much of the Ethiopian highlands. This likely limits the ability of farmers to invest in planting many kinds of biological measures to control erosion and restore soil fertility, since such measures may be destroyed by grazing or trampling. Thus, improvements in management of farmlands may depend upon changes in the grazing system and improvements in the management of grazing areas.

Other issues such as fertilizer and input credit supply are less important where a low external input strategy is pursued than where a high input strategy is pursued, since such areas will have lower demand for these inputs. Nevertheless, these areas should not be neglected in this regard since the small amounts of inputs and credit they use may be highly important. Other kinds of credit, particularly credit for productive nonagricultural purposes (such as petty trading) and for consumption purposes may be highly important in addressing problems of poverty and food insecurity. Development of road infrastructure, storage facilities and the output marketing system will be less important to such areas as suppliers of food, but critical to them as net importers of food.

2.5 INTENSIFICATION OF LIVESTOCK PRODUCTION

The most widespread technical constraint to intensified livestock production in Sub-Saharan Africa is the availability of feed. McIntire et al. (1992); Winrock International (1992). In the densely populated highlands, the prospects for relaxing this constraint through increased forage production in farmlands is limited (except where high-value dairy production exists), given the scarcity of land and food. McIntire et al. (1992). Except in less densely populated parts of the highlands, the potential for increased fodder production in communal grazing areas and wastelands is also limited, as discussed above. Imported feed and feed concentrates are likely to be of limited use, except in very commercialized systems such as dairy production in Kenya. This implies that the policy and institutional requisites of cereal crop intensification discussed above are also critical to livestock intensification.

Other important constraints to intensified livestock production in the Kenyan highlands include animal diseases, limited stock of improved breeds, limited availability of veterinary services and other inputs, poor infrastructure, and limited market and institutional development. Winrock International (1992). While it is desirable to address all of these constraints wherever they are binding, priority should be given in the near term to places where there is substantial commercial potential and where the feed constraint is not binding. For example, improved dairy breeds are not likely to be used where adequate feed cannot be assured or only limited commercial potential exists, given their cost and greater demand for feed. Returns to investment in veterinary services, infrastructure and marketing facilities will be much greater where commercial potential exists and feed is adequate than elsewhere. Thus, such efforts should be targeted in the near term to areas close to urban markets, particularly where dairy potential exists, since the returns to this activity are relatively high. McIntire et al. (1992); Jahnke (1982).

Development of dairy cooperatives may be a critical component of a strategy to develop dairy production in areas of high market access. Because of the bulky, highly perishable, and easily contaminated nature of fluid milk, the transaction costs and risks involved in marketing milk are very high. Staal et al. (1997). Dairy cooperatives help to reduce risks and transactions costs facing individual producers by pooling risk, reducing unit costs due to economies of scale in collection and transport, making inputs available, and enhancing their bargaining power. They reduce costs faced by processors by reducing

milk acquisition costs and assuring the quality and reliability of the supply. In addition, dairy cooperatives may contribute to the development of social capital; for example, by investing in education and health facilities.

Dairy cooperatives have played a potent role in dairy development in Kenya. The government of Kenya has promoted dairy development for many years through the Kenya Cooperative Creameries (KCC), which acts as a stable market outlet for smallholder dairy producers and private cooperatives. This undoubtedly contributed to the success of dairy development in Kenya, but has had problems in recent years as poor financial performance of KCC (due in part to policies of pan territorial and pan seasonal pricing) caused delays in payments to private cooperatives and producers (ibid.). The Kenyan government liberalized the dairy industry in 1992, eliminating KCC's monopoly on processed milk sales (but not on raw milk sales) in urban areas.

Development of other intensive commercial livestock enterprises such as beef fattening and poultry and pork production is constrained mainly by the need for low-cost feed, though religion also plays a strong role with regard to pork consumption. Where domestic feed supplies are limited, avoiding restrictions on imported feed concentrates could help such enterprises to develop. Once demand for such concentrates becomes sufficiently developed, and domestic production of cereals increases sufficiently, local production of feed concentrates may become profitable. Ensuring a policy environment attractive to foreign and domestic investors could be an important element in facilitating such development.

Development of such commercial intensive livestock industries would greatly increase the availability of manure. Given the high cost of transporting manure, the direct impacts on soil fertility would be limited mainly to areas close to the urban markets where these industries develop. However, the increase in supply of such organic material might be used to develop domestic industries supplying more concentrated fertilizer or fuel, which could have a significant impact even in areas further from the urban market.

An attractive policy environment could also help facilitate investment in this type of venture. In more remote areas, focusing on increased fodder production (through increased cereal production, forage crops and/or fodder trees) may be the greatest opportunity in the near term. Given improved fodder production, there will be opportunities to promote increased productivity in small ruminant production, particularly in lower population density settings, together with improved grazing land management. Public measures to control or eliminate animal diseases are justified in remote areas as well as commercial areas for both efficiency reasons (due to the public goods nature of the investment) and to address rural poverty and food insecurity.

3.0 COMMERCIAL PRODUCTION OF PERISHABLE CASH CROPS

Where there is very good access to markets and irrigation or sufficiently reliable rainfall, intensive commercial production of perishable fruits and vegetables can be very profitable. As with intensified livestock production, the ability to pursue this strategy may

depend upon the success of increased productivity of cereal production, though for a slightly different reason. Risk averse farmers with very little land are usually reluctant to gamble on new and highly risky crops, however potentially profitable, unless their food security is assured (von Braun et al. 1991). Such assurance need not depend only on local food production though.

For example, small farmers in western Kenya are adopting vegetable crops and importing maize from Uganda. Open trade policies thus can be very helpful in allowing such commercialization to occur. Nonfarm income can also provide sufficient food security to allow commercialization to occur (ibid.). But in cases such as in much of central Ethiopia and parts of Uganda, where a potential comparative advantage in cereal production exists, realizing that potential can be an important first step towards enabling farmers to diversify into higher value products. Thus the requisites of high-external input intensification of cereals also most likely help to promote intensive production of perishable cash crops in such cases. At the same time, income earned from such cash crop production can help farmers intensify food crop production, by enabling them to purchase more inputs. Thus increased cash crop production and increased food crop production may be mutually reinforcing strategies.

One important constraint may be lack of knowledge about such products, especially their market potential. Technical assistance, emphasizing market opportunities for different crops as well as crop management, can be very important. With fresh horticultural products, local markets can quickly become saturated, causing dramatic price declines. It is critical for farmers to be aware of the potentials and problems of alternative crops, so that they can diversify their production. Information on prices in local markets, announced over radio, could also be helpful.

Such technical assistance need not come only from government extension agents however. In other parts of the world, farmers often obtain advice from other farmers, input suppliers or traders. As the input marketing system develops, local suppliers will become more knowledgeable and able to provide advice to farmers. Providing training to suppliers as well as farmers could help this process. For some things, however, technical assistance probably must be provided (or at least financed) by governments, due to incentives facing private suppliers. For example, integrated pest management and organic farming methods may not be adequately promoted (relative to their potential benefit) by private input suppliers, since these methods may reduce their sales of agrochemicals. Training is also needed on proper use and disposal of pesticides, which are likely to be much more widely used where horticultural development is occurring.

Another important role for the state in promoting horticultural crop development is to open up international trade in seeds. The role for research on new varieties may be more limited than for cereals or other major crops, due to the wide variety and relatively small amounts produced of any particular horticultural crop.

Where irrigation is used in production of cash crops, conflicts may arise over access to water and management of irrigation systems. Well functioning institutions are needed to

allocate use rights and enforce responsibilities. As with institutions to manage grazing lands (discussed above), such effective institutions may not arise spontaneously, but may be catalyzed by appropriate interventions by external agents. Baland and Platteau (1996). On the other hand, external intervention may undermine the effectiveness of local management and increase the potential for conflict (ibid.). Thus a careful approach to promoting development of such institutions is warranted, taking full account of local conditions and concerns before investing in irrigation schemes or identifying the strategy to address issues of rights and responsibilities. For example, one microdam was recently completed by SAERT in Tigray, even though the former users of land flooded by the new reservoir have not yet been allocated any land in the command area. Such a situation could cause serious difficulties to the households who have lost land and lead to conflicts that undermine confidence in the overall effort, which otherwise appears to be achieving impressive results. In other cases in Tigray, local community councils have been very involved in such decisions from the outset, and land in the command area has been allocated to all affected households; resulting in broad support for the effort.

Available input supply and credit to finance input purchases are of course important for producers of horticultural crops, as they are for high input production of cereals. Given the high expected returns to such inputs, linking future credit to repayment of past loans can provide a strong incentive to repay. However, since such crops are highly risky (particularly price risk), lenders may be reluctant to lend as much as farmers desire where collateral is limited, as in Ethiopia where land cannot be mortgaged. Where land can be mortgaged, farmers may be reluctant to borrow due to the risk involved, even if the expected profits are high. Alternative institutional arrangements, such as sharecropping and contract farming, can be used as a means of reducing risks and obtaining access to short term capital.

Tenure insecurity, restrictions on leasing, and land fragmentation may limit commercialization of perishable cash crops for the same reasons cited earlier in discussing factors affecting investments in land improvement. These factors are particularly important with respect to planting fruit trees, which of course require long-term tenure security, and protection against theft or being cut for fuelwood. Where such security is lacking, investments in fruit trees are likely to be limited to plots near the homestead.

Where there is potential for developing processing and/or export, the availability of cold storage, processing and transport facilities may be critical constraints. The availability of electricity is one factor that may constrain the development of such facilities. Where electricity is not available, storage facilities and processors may use diesel generators, although the costs may be high, especially where fuel taxes are high. Commercial credit or equity capital also will be needed. Provision of infrastructure and lines of credit for such purposes and maintaining a policy environment that facilitates private investment are thus likely to be very important to achieve this potential. Development of processing can also promote contract farming or cooperatives, since processors will seek to assure themselves a reliable supply.

There is good potential for sustainable land management where horticultural production is occurring, but there are also risks. Such high-value, labor-intensive production may reduce pressure on land by providing farmers' sufficient income on a smaller area of land. It can contribute to agro-biodiversity and help to reduce pest problems if used in rotations with primary staple crops. Pingali and Rosegrant (1995). Horticultural production can encourage investment in soil conservation by increasing returns to such investments. For example, Tiffen et al. (1994) found a strong association between adoption of horticultural crops and construction of bench terraces in the Machakos district of Kenya. The cash income generated by horticultural production also provides incentive and ability to purchase fertilizers, which may restore soil fertility. This effect is not assured, however, since multiple cropping of horticultural crops can rapidly deplete soil nutrients even when increased fertilizers are applied. Education and extension efforts can help to address such problems, though farmers may simply find it too risky or costly to apply sufficient amounts of fertilizer to avoid this problem. Other potential problems include contamination of soil and water and human health risks caused by agrochemicals, and increased conflicts over water. Applied research and extension related to integrated pest management, integrated nutrient management, and water management are critical to minimize such risks and attain the greatest possible benefits from this development strategy.

4.0 HIGH-VALUE NON-PERISHABLE PERENNIAL CROPS

Given the time lags required to receive the benefits of investment, expansion of production of high-value perennial crops such as coffee and tea where land is scarce depends upon first assuring food security. Since areas with a comparative advantage in such non-perishable crops will tend to be further from markets than dairy or horticultural areas, relying on imported food is likely to be more costly than local production. Increased food production therefore must be high priority for such areas, with the goal being elimination of local food deficits and freeing up of scarce land for the production of higher value crops. The policy and institutional requisites thus include those discussed earlier to achieve high input intensification of cereal production, including consideration of subsidies on the transport cost of fertilizer in the near term until food deficits are eliminated and income from perennial crop production is growing.

Many of the requirements for other commercial strategies mentioned earlier are also important for high-value perennials. Investment in roads, land tenure security, and land transactions (to reduce fragmentation) are critical. Research and extension to promote use of improved varieties and improved management is needed. Some of this can be (and is) financed by fees on commercial producers; however, there may still be a need for public sector research and extension to reach small producers using low technology methods, such as producers of forest coffee in Ethiopia. Promotion of private nurseries (for example, through availability of credit) can be helpful. Credit to finance inputs and purchase of tree seedlings can also be helpful. Development of processing facilities and assuring adequate capacity utilization of such facilities is important, especially for tea (von Braun et al. 1991). The need to assure a sufficient quantity and reliability of supply to make such facilities profitable contributed to the attractiveness of large plantations

established by colonial settlers in Kenya. Development of alternative institutional arrangements more appropriate to smallholder production, such as cooperatives or contract farming, can help to achieve the same goals. Large processing facilities are less necessary for coffee than tea if coffee is sold in unwashed form, but the value-added in the local economy is reduced. To be able to tap this potential, substantial investments in coffee washing facilities are now occurring in coffee producing areas of Ethiopia. Ethiopian Herald, (May 7, 1998). Maintaining a policy environment conducive to development of cooperatives and such investments in processing are key to attaining the potential of this strategy. The benefits of development of high-value perennial crops for the sustainability of land use can be substantial. As with annual horticultural crops, the income generated can help reduce pressure to continue producing or expanding onto marginal lands and allow greater use of inorganic fertilizers, while the increase in land values encourages investments in land improvements.

In contrast to annual cash crops, high-value perennials are a less erosive land use. Where coffee is grown in shaded conditions, there is good potential to plant other kinds of trees for soil fertility management, fodder and/or fruit production, increasing the benefits for land management and farm incomes. There is evidence from western Kenya that soil fertility depletion is lower where perennial cash crops such as coffee and tea are grown than where annual food crops are grown for commercial purposes. De Jager et al. (1998). As with horticultural crops, however, there are risks posed by increased use of agrochemicals in the production of such crops. Thus, extension and training will play an important role in promoting appropriate practices of integrated soil nutrient management and integrated pest management.

5.0 RURAL NONFARM DEVELOPMENT

In areas close to roads and markets, rural nonfarm activities are usually an important source of employment and income. Delgado et al. (1994); von Braun et al. (1991). Where commercial agricultural production is expanding, as in central and parts of western Kenya, linkages to agricultural input supply, processing, and trading are particularly important. For example, off-farm income exceeds half of total income for farmers in western Kenya (the proportion is higher for lower income farmers), and much of this comes from small enterprises engaged in such agriculturally related activities. Crowley et al. (1996). Thus many of the requisites for this strategy are the same as those discussed above for the commercial agricultural development strategies.

Beyond development of commercial agriculture, the key requirements for this strategy include development of infrastructure (especially roads and electricity) and transportation facilities, education and vocational training, availability of credit and savings to help finance small startup enterprises and equity capital for medium and larger enterprises (access to credit usually not a problem for larger enterprises). It is important to maintain an environment conducive to investment; for example, by reducing delays in licensing procedures, facilitating purchase or long-term leasing of land and buildings by enterprises in urban and peri-urban areas, reducing taxes and broadening the tax base. Restrictions on labor mobility caused by restrictions on land sales or leasing in rural areas (as in

Ethiopia) can also be an important constraint inhibiting migration of workers to areas where employment demand is high. However, shortages of skilled workers resulting from low education and inadequate training facilities is probably a more critical constraint. High priority should be given to improved education in all areas, and to establishing training facilities where potential for nonfarm development exists.

The impacts of nonfarm development for sustainable land management are less direct than the effects of the agricultural development strategies, but may be larger and more profound in the long run. Nonfarm income enables households to save and to overcome capital market imperfections that may cause households to discount the future heavily and limit their ability to invest in commercial crop production, inputs or land improvements. Crowley et al. (1996); Reardon et al. (1996); Pender and Kerr (1998); Clay et al. 1995). Such development can provide farmers an alternative to continuing depletion of soil, forests and other resources. Pinstrup-Andersen and Pandya Lorch (1995). On the other hand, nonfarm development may reduce farmers' incentive to invest in land improvement, by increasing the opportunity cost of their time. Pender and Kerr (1998); Clay et al. (1995). It is thus important to promote less labor intensive strategies of land management—such as planting trees rather than annual crops—in areas where nonfarm employment opportunities are increasing the value of labor.

6.0 EMIGRATION

Related to nonfarm development is the strategy of emigration, both seasonal and permanent. Areas with low agricultural potential and low market access are likely to be particularly large sources of outmigration, though emigration from all areas of the rural highlands is likely given the high population density and small farm sizes. The feasibility of this strategy depends largely upon nonfarm development; thus the requisites of the strategy include the requisites of nonfarm development. There is also potential for seasonal rural-rural migration within the highlands from low-potential areas to higher potential or irrigated areas during the dry season, and in some cases there may be potential for permanent rural-rural migration to reduce disparities in across locations (though generally high population density throughout the highlands makes this difficult).

The need for education and training for people in areas of outmigration should be emphasized. Land tenure is also a key issue affecting migration. People without secure tenure are unlikely to risk losing their land by taking jobs in the city. The scope for permanent rural-rural migration is also affected by host area tenure policies affecting opportunities for land purchasing or leasing. This will be less important with regard to seasonal migration, although availability of land to establish housing for seasonal immigrants is important. Education policies also can affect possibilities for inter-regional migration: for example, different languages are now being taught in different regions of Ethiopia, which will likely increase barriers to inter-regional migration.

7.0 CONCLUSIONS AND HYPOTHESES

In this paper i have argued that the policy and institutional requirements for sustainable development depend upon the pathway of development that is pursued, and that the appropriate development pathways depend upon the factors determining potential comparative advantage—especially agricultural potential, access to markets and population pressure. Several generic development pathways have been identified, including high external input intensification of food production, low external input intensification of food production, livestock intensification, commercial production of perishable (mainly horticultural) crops, commercial production of high-value non-perishable (mainly perennial) crops, rural nonfarm development, and emigration. We have argued that success of the commercial agricultural development pathways is largely conditional upon increased food crop production, particularly in areas with poor market access with potential for high-value perennial crop production.

Opportunities for intensified commercial production of crop and livestock products are very good in much of the highlands, where agricultural potential is high. The opportunities for agricultural development in low-potential areas are more limited, although there appears to be good potential to increase the overall productivity of land use through better management of grazing lands and wastelands, particularly in lower population density areas where substantial areas of such lands are still present. In higher population density, low- potential areas with good market access, there may be good potential for investments in irrigation or rural nonfarm development (though rural nonfarm development may need to depend upon linkages to sectors such as manufacturing or mining where agricultural potential is low). In high population density, low-potential areas with poor market access, emigration is bound to be a major element of people's livelihood strategies. Although many policy prescriptions are valid in general, consideration of the key constraints likely to be binding in the different situations discussed suggests a number of hypotheses about where public policy and investment priorities should be placed:

1. The highest priority for road development should be areas relatively close to urban markets where there is high agricultural potential or high irrigation potential. The highest priority for irrigation development is also in these areas; particularly dryer areas, although supplemental irrigation in higher rainfall areas can also be very valuable. Such development could enable intensive production of food crops, high-value perishable cash crops, and dairy products. Where irrigation investment is occurring, adequate attention must be given to institutional issues, such as how water will be allocated and how losers will be compensated, prior to physical construction.

2. Where such commercial potential exists, food security is a key to allowing farmers to exploit the opportunities available. Where farmers have substantial off-farm income, they may be willing and able to specialize in cash crop production. However, where such opportunities are more limited (or more limited for income farmers), the risks associated with cash crop production may require increases in food productivity to enable greater cash crop production. Increased cash crop production may also help promote increased

food crop production (by enabling purchase of inputs), so that both food and cash crop production may increase for some time before greater specialization occurs. Similar complementary growth of food crop and dairy production may occur in the early phases of development. Research and extension programs should recognize and exploit such complementarities.

3. Assuring adequate provision of inputs and credit, and development of the marketing system are critical to all commercial strategies. Development of processing facilities and marketing institutions (such as cooperatives and contract farming), facilitated by a supportive policy environment, are needed. Research and extension programs will need to take a broader focus, emphasizing market opportunities for new commodities, management of animal health, integrated pest management, and integrated soil nutrient management.

4. Second priority for road development should be high-potential areas further from markets, especially where population density is high. There is good potential for intensified production of high-value perennial crops in these areas if roads are adequate. However, achieving this potential first requires assuring food security, which is likely to be most economical by increasing productivity in food crop production. For the near term, subsidies on the cost of transporting fertilizer and other inputs to such areas (if they are food deficit areas) should be considered as a lower cost alternative to food aid. As food deficits are eliminated and increased income from perennial crops generated, such subsidies should be eliminated. More generally, there is a need to increase the availability and ensure competitive prices of agricultural inputs. A high priority for such areas is also elimination of land redistributions and avoidance of restrictions on land sales or long term leasing, so that the problems of land tenure insecurity and land fragmentation can be reduced.

5. For low-potential areas without good potential for irrigation (especially with lower population density), priority should be placed on promoting increased productivity of all land, including grazing lands and wastelands. Cautious efforts are needed by governments and NGOs to catalyze development of local institutions in order to intensify management of grazing lands. Contingent upon intensified grazing land management, some intensification of livestock production is possible. Increased production of small ruminants may be a particularly profitable strategy. Allocation of wastelands and sloping lands for private tree planting has potential to substantially reduce the biomass shortage in some areas, as well as increasing household wealth and incomes, though the potential for income generation is greater closer to markets. In the near term, food aid may be needed in such areas, though priority should be given to developing alternative sources of income as well as increasing land productivity.

6. For low-potential areas with good market access, good opportunities for rural nonfarm development may exist, though these may depend upon non-agricultural activities, such as manufacturing and mining, given low agricultural potential. Priority should be on investment in infrastructure (especially electricity), availability of credit to finance startup enterprises, and education and training of the labor force.

7. For low-potential areas with poor market access (especially with high population density), emigration should be facilitated. High priority should be placed on education and training. Allowing land sales or long-term leases could also help to facilitate emigration and less intensive use of the land.

It is important to emphasize that these are only hypotheses, based upon theoretical considerations and a very limited amount of empirical evidence. Furthermore, there is certainly substantial variation within the broad types of situations discussed, and across households having access to different resource endowments. Addressing problems of poverty, low agricultural productivity and resource degradation will therefore require strategies that address the needs of the poor as well as the more well-endowed. Nevertheless, identifying the broad strategies of development that are feasible can help to identify and recommend targeted strategies for specific situations. Making recommendations about specific strategies will require more detailed information about the costs and benefits of alternative strategies in different situations, the priorities and concerns of key stakeholders, and other factors that will determine the likely success or failure of such recommendations. Policy research is needed to address these issues. We hope that this paper will help to provide impetus and guidance to such research.

8.0 REFERENCES

Binswanger, H.P., and J. McIntire. 1987. Behavioral and material determinants of production relations in land-abundant tropical agriculture. *Economic Development and Cultural Change* 36 (1): 73-99.

Bojo, J., and D. Cassells. 1995. *Land degradation and rehabilitation in Ethiopia: A reassessment*. AFTES Working Paper No. 17. Washington, D.C.: World Bank.

Boserup, E. 1965. *The conditions of agricultural growth: the economics of agrarian change under population pressure*. New York: Aldine Publishers.

Braun, A.R., E.M.A. Smaling, E.I. Muchugu, K.D. Shepherd, and J.D. Corbett. 1997. Maintenance and improvement of soil productivity in the highlands of Ethiopia, Kenya, Madagascar and Uganda. AHI Technical Report Series No. 6, African Highlands Initiative, Nairobi, Kenya.

Bumb, B.L., and C.A. Baanante. 1996. *The role of fertilizer in sustaining food security and protecting the environment to 2020*. Food, Agriculture and the Environment Discussion Paper 17. Washington, D.C.: International Food Policy Research Institute.

Clay, D., F. Byiringiro, J. Kangasniemi, T. Reardon, B. Sibomana, and L. Uwamariya. 1995. Promoting food security in Rwanda through sustainable agricultural productivity: Meeting the challenges of population pressure, land degradation, and poverty. Department of Agricultural Economics Staff Paper No. 95-08, Michigan State University.

Cleaver, K.M., and G.A. Schrieber. 1994. *Reversing the spiral: The population, agriculture and environment nexus in Sub-Saharan Africa*. Washington, D.C.: World Bank.

Cooper, P.J.M., R.R.B. Leakey, M.R. Rao, and L. Reynolds. 1996. Agroforestry and the mitigation of land degradation in the humid and sub-humid tropics of Africa. *Experimental Agriculture* 32: 235-290.

Crowley, E.L., M.J. Soule, and S.E. Carter. 1996. Off-farm income and farming in western Kenya. International Centre for Research in Agroforestry and Tropical Soils Biology and Fertility Programme, Nairobi, Kenya. Mimeo.

de Jager, A., I. Kariuki, F.M. Matiri, M. Odendo, and J.M. Wanyama. 1998. Monitoring nutrient flows and economic performance in African farming systems (NUTMON). IV. Linking nutrient balances and economic performance in three districts in Kenya. *Nutrient balances as indicators of productivity and sustainability in Sub-Saharan African agriculture*, ed. E.M.A. Smaling. Special Issue of *Agriculture Ecosystems & Environment* 71: 81-92.

Delgado, C. 1995. *Africa's changing agricultural development strategies: Past and present paradigms as a guide to the future*. Food, Agriculture, and the Environment Discussion Paper 3. Washington, D.C.: International Food Policy Research Institute.

Delgado, C.L., J.C. Hopkins, and V.A. Kelly. 1994. Agricultural growth linkages in Sub-Saharan Africa. International Food Policy Research Institute, Washington, D.C. Mimeo.

Ehui, S.K., B.T. Kang, and D.S.C. Spencer. 1990. Economic analysis of soil erosion effects in alley cropping, no-till and bush fallow systems in south western Nigeria. *Agricultural Systems* 34: 349-368.

Freeman, H.A., S.K. Ehui, and E.N. Betubiza. 1998a. Supply of institutional credit for smallholder livestock producers in Uganda, Ethiopia and Nigeria. In *The role of credit in the uptake of improved dairy technology in Sub-Saharan Africa*, ed. H.A. Freeman, M.A. Jabbar, and S.K. Ehui. Socioeconomics and Policy Research Working Paper No. 21, International Livestock Research Institute, Addis Ababa. Forthcoming.

Freeman, H.A., S.K. Ehui, and M.A. Jabbar. 1998b. Credit constraints and smallholder dairy production in the East African highlands: application of a switching regression model. *Agricultural Economics*. Forthcoming.

Gezahegn A., and F. Heidhues. 1998. Analysis of innovation, dissemination and adoption of vertisol technology: Some evidence from the highlands of Ethiopia. Paper presented at the Soil Fertility Management Workshop, Addis Ababa, April 21-23.

Hayami, Y., and V.W. Ruttan. 1985. *Agricultural development: An international perspective*, 2 nd ed. Baltimore, Md.: Johns Hopkins University Press.

Hoekstra, D. A. 1988. Summary of zonal agroforestry potentials and research across land use systems in the highlands of Eastern and Central Africa. No. 15. Agroforestry Research Network for Africa. International Centre for Research in Agroforestry.

Hoekstra, D., and J.D. Corbett. 1995. Sustainable agricultural growth for the highlands of East and Central Africa: Prospects to 2020. International Food Policy Research Institute, Washington, D.C. Mimeo.

International Food Policy Research Institute (IFPRI). 1995. *A 2020 vision for food, agriculture, and the environment: The vision, challenge, and recommended action*. Washington, D.C.: IFPRI.

Jahnke, H.E. 1982. *Livestock production systems and livestock development in tropical Africa*. Kiel, Germany: Kieler Wissenschaftsverlag Vaug.

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

Minae, S., and D. Nyamai. 1988. Agroforestry research project proposal for the coffee based system in the bimodal highlands, central and eastern provinces, Kenya. AFRENA Report No. 16. Nairobi, International Centre for Research in Agroforestry.

Mwangi, J.G. 1999. Policy milestones in Kenya that have supported or constrained sustainable agriculture and poverty alleviation. Tegemeo Institute of Egerton University, Kenya. Mimeo.

Nyoro, J., and H. Muiruri. 1999. Sustainable agriculturally-based rural livelihoods: Mwea study site. Tegemeo Institute of Egerton University, Kenya. Mimeo.

Olson, J.M. 1995. Natural resource management by farmers in Kabale District, Uganda. International Centre for Research in Agroforestry, Nairobi, Kenya. Mimeo.

Palm, C.A., R.J.K. Myers, and S.M. Nandwa. 1997. Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. In *Replenishing soil fertility in Africa*, ed. R.J. Buresh, P.A. Sanchez, and F. Calhoun. Madison, Wisc.: Soil Science Society of America, Inc. and American Society of Agronomy, Inc.

Pender, J.L. and J.M. Kerr. 1998. Determinants of farmers' indigenous soil and water conservation practices in semi-arid India. *Agricultural Economics* 19: 113-125.

Pingali, P.L. and M.W. Rosegrant. 1995. Agricultural commercialization and diversification: processes and policies. *Food Policy* 20 (3): 171-185.

Pinstrup-Andersen, P., and R. Pandya-Lorch. 1995. *Alleviating poverty, intensifying agriculture, and effectively managing natural resources*. Food, Agriculture and Environment Discussion Paper 1. Washington, D.C.: International Food Policy Research Institute.

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

Place, F., and K. Otsuka. 1997. Population pressure, land tenure, and tree resource management in Uganda. EPTD Discussion Paper No. 24. Washington, D.C., International Food Policy Research Institute.

Place, F., and S.E. Migot-Adholla. 1998. Land registration and smallholder farms in Kenya. *Land Economics* 74 (3): 360-373.

Quinones, M.A., N.E. Borlaug, and C.R. Dowswell. 1997. A fertilizer-based green revolution for Africa. In *Replenishing soil fertility in Africa*, ed. R.J. Buresh, P.A. Sanchez, and F. Calhoun. Madison, Wisc.: Soil Science Society of America, Inc. and American Society of Agronomy, Inc.

Ruthenberg, H. 1980. *Farming systems in the tropics*. 3rd ed. Oxford: Clarendon Press. Sanchez, P.A., K.D. Shepherd, M.J. Soule, F.M. Place, R.J. Buresh, A.N. Izac, A.U.

Staal, S., C.L. Delgado, and C.F. Nicholson. 1997. Smallholder dairying under transactions costs in East Africa. *World Development* 25: 779-794.

Staal, S.J. and B.I. Shapiro. 1994. The effects of recent price liberalization on Kenyan peri-urban dairy: A case study using the policy analysis matrix approach. *Food Policy* 19 (6): 533-549.

Tiffen, M., M. Mortimore, and F. Gichuki. 1994. *More people, less erosion: Environmental recovery in Kenya*. New York: John Wiley & Sons.

von Braun, J., H. de Haen, and J. Blanken. 1991. *Commercialization of agriculture under population pressure: Effects on production, consumption, and nutrition in Rwanda*. Research Report 85. Washington, D.C.: International Food Policy Research Institute.

Winrock International. 1992. *Assessment of animal agriculture in Sub-Saharan Africa*. Morrilton, Ark.: Winrock International Institute for Agricultural Development.

World Bank. 1994. *Adjustment in Africa: Reforms, results, and the road ahead*. World Bank Policy Research Report. New York: Oxford University Press.

World Bank. 1996. *Uganda: the challenge of growth and poverty reduction*. Country Study. Washington, D.C.: World Bank.

World Report, Ltd. 1998. World report on Ethiopia. March.