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Rural Investments to Accelerate Growth and Poverty Reduction in Kenya

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Jane Kiringai, Kenya Institute for Public Policy Research and Analysis
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Development Strategy and Governance Division

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ABSTRACT

Kenya's economy is relatively diverse, with both agricultural and industrial potential. However, the economy has performed poorly over the last decade, and poverty and inequality have risen. This paper examines the impact of alternative growth paths and rural investments on poverty using an economy-wide model. It finds that if Kenya continues along its current growth path, its economy will have to grow by more than 10 percent per year over the coming decade to meet the Millennium Development Goal (MDG) of halving poverty by 2015. Therefore, Kenya must search for alternative sources of poverty-reducing growth. The results of the model indicate that poverty is unlikely to decline significantly without an acceleration of agricultural growth. Growth in agriculture is found to benefit both urban and rural households, whereas industry-led growth benefits a smaller segment of the urban population, thus exacerbating inequality. Kenya's current Economic Recovery Strategy, however, is not optimistic about agriculture's growth potential, focusing more heavily on industry-led growth. Therefore, as Kenya prepares its new national strategy, the country should place greater emphasis on and direct resources toward accelerating agricultural growth.

In assessing the impact of rural investments on growth and poverty, the paper finds that increasing agricultural spending to meet the 10 percent target set by the Maputo Declaration would lift an additional 1.5 million people above the poverty line by 2015. Specific agricultural investments have higher returns in different parts of the country, however. Irrigation favors the lowlands and the poorest segment of the population, while research and extension (R&E) favors the midlands and highlands. Investment in R&E is also found to have the highest returns in both growth and poverty reduction. However, increasing agricultural spending to 10 percent of total spending is insufficient to meet either the MDG or the 6 percent agricultural growth target of the Comprehensive African Agriculture Development Program, which Kenya has recently adopted. . Achieving this target requires nonagricultural investments, such as in roads and market development. Building rural roads and reducing agricultural transaction costs significantly reduces poverty and encourages growth beyond rural areas. While it is necessary to increase spending on agriculture, the fiscal burden of an agricultural strategy can be greatly reduced by improving investment efficiency.

Keywords: agriculture, rural investment, poverty, inequality, Kenya, Africa

1. INTRODUCTION

Kenya's economy is diverse, with both agricultural and industrial potential. However, the economy has not performed well over the last decade, and evidence indicates that poverty and inequality have worsened. Therefore, it is imperative that Kenya's government fosters stronger growth and a process of income generation that benefits the broader population. As discussed in the next chapter, numerous studies emphasize the importance of rural development in Kenya, largely because a majority of the population, especially poor households, lives in rural areas, where they rely heavily on agricultural incomes. Urban households also depend on rural areas as a source of food and as a market for nonagricultural goods. However, Kenya's current strategy does not take an optimistic view of agriculture's potential contribution to economic growth. This strategy emphasizes creation of a dynamic industrial sector that can provide employment opportunities and improve incomes. These objectives are important if Kenya is to diversify its economy and encourage long-term structural transformation. However, the current strategy is drawing to a close and has not yet established rapid economic growth. This again raises questions about potential sources of growth and appropriate allocations of public investments.

It appears that agriculture might play a more important role in the country's future strategy. The government has recently adopted the Comprehensive Africa Agriculture Development Program (CAADP) promulgated under the New Partnership for Africa's Development (NEPAD). This program sets a continent-wide agricultural growth target of 6 percent. To achieve this growth, Kenya's government has signed the Maputo Declaration, which calls on African governments to increase the share of agricultural spending to 10 percent of their total budgets.

In light of these developments, this paper assesses alternative growth paths for Kenya in terms of their ability to reduce poverty. It also assesses the impact and fiscal implications of investing in agriculture and rural infrastructure in order to accelerate agricultural growth. Chapter 2 reviews Kenya's recent economic performance, its existing development strategy, and the role of agriculture in the economy. Chapter 3 estimates the impact of Kenya's current growth path on poverty, using a dynamic economy-wide model. The study finds that there are unlikely to be significant reductions in poverty under the current growth path. Furthermore, Kenya would have to grow extremely fast over the coming decade if it is to meet the Millennium Development Goal (MDG) of halving poverty by 2015. Accordingly, Kenya must search for alternative sources of poverty-reducing growth. Here we compare alternative growth options and find strong support for focusing greater attention on agriculture. Achieving the 6 percent agricultural growth target will significantly reduce poverty. Chapter 4 describes a possible investment strategy borne out of the 10 percent expenditure target set by the Maputo Declaration, by

extending the economy-wide model to include a public investment function and, drawing on the literature, simulating increasing public spending on irrigation, research and extension, and rural roads. The results suggest that the 10 percent expenditure target is insufficient to achieve 6 percent agricultural growth unless the efficiency of public spending is improved. Meeting the agricultural growth target will require additional spending in rural infrastructure and market development. The paper concludes by summarizing the findings and providing recommendations for a more equitable growth strategy in Kenya.

2. GROWTH, POVERTY AND AGRICULTURE IN KENYA

Recent Performance and Policies

Kenya has grown at an average rate of about 3 percent per year since reforms started in earnest during the early 1990s (see Table 1). This apparent continuity hides the volatility of growth over this period, as well as its shifting structure. For instance, agricultural growth was initially slow during the mid-1990s but rose rapidly to almost 5 percent before declining again after 2000. By contrast, the industrial sectors have followed the opposite trend, falling into stagnation during the late 1990s, then rising to average about 2 percent growth overall. Some of the volatility in growth has undoubtedly been the result of reforms. Macrostabilization policies were aimed at lowering inflation and interest rates and ensuring a more stable exchange rate. These reforms were only partially successful: inflation and interest rates fell but did not stabilize. Exchange rate policies have proven more successful, although in recent years there has been a real appreciation that has favored imported capital goods but also raised concern over the competitiveness of agricultural exports.

Table 1. Past and projected growth performance, 1992–2007

	GDP share	Observed annual real compound growth rate (%)				ERS proj.
	in 1997	1992-97	1997-2000	2000-04	1997-2004	2003-07
GDP market prices	100.0	2.9	2.1	3.0	2.6	6.0
Households	75.1	3.1	1.5	2.6	2.1	4.7
Investment	15.0	7.8	7.2	3.0	4.8	12.7
Government	17.3	3.4	-0.4	1.5	0.7	3.0
Exports	22.4	8.7	1.7	9.9	6.3	7.7
Imports	29.8	12.2	1.7	6.8	4.6	6.0
GDP factor cost	100.0	3.0	1.8	2.7	2.3	6.0
Agriculture	18.1	1.7	4.3	2.6	3.3	3.1
Manufacturing	22.4	2.6	-0.5	2.1	0.8	8.6
Other industry	9.1	2.3	0.9	2.0	1.5	11.3
Private services	39.7	4.8	2.2	3.2	3.2	3.0
Public services	10.7	1.6	1.4	2.6	1.9	3.0
Population	. . .	2.6	2.4	1.9	2.1	2.0

Source: GK 2003b; 2006
Note: GDP is gross domestic product in constant 2001 prices; ERS is Economic Recovery Strategy projections.

Investment remained high during the 1990s despite lingering macroeconomic instability. However, this has not translated into more rapid economic growth, with capital being increasingly underutilized in the manufacturing sector. This may be due to the sequencing of reforms since macrostabilization was implemented alongside privatization and liberalization. While trade liberalization has been ongoing since the mid-1980s, the effect of foreign competition has been a slowdown in industrial growth during the 1990s. Domestic liberalization was also pronounced. Prior to reforms the

government was heavily engaged in agricultural markets, primarily through marketing boards that managed most areas of the sector from input provision to marketing and exporting. During the reform period the government abolished many of these boards and removed price controls in order to shift the function of the state away from active participation toward market regulation. While it is difficult to determine the effects of reforms, both agriculture and industry were affected and have performed better during the postreform period.

Economic growth was offset by high population growth, so that average per capita incomes stagnated during the 1990s. However, average income measures ignore the distribution of incomes and therefore provide only a rough indication of changing household welfare. Direct poverty measurement is preferable but difficult in Kenya. Three household surveys that estimate the level and distribution of poverty have been conducted over the last 10 years. However, differences in the design and implementation of these surveys prevent an accurate comparison of poverty over time. For instance, the 1992 Welfare Monitoring Survey (WMSI) covered half of the country, the 1994 WMS(II) covered all the districts, and the 1997 WMS(III) excluded the North Eastern province (Table 2).

Table 2. Changes in the incidence of poverty, 1992–2000

	Poverty incidence or headcount (P0)					
	1992 WMSI	**1994a WMSII**	**1994b WMSII**	**1997 WMSIII**	**1999/2000 Census**	**2000 Projected**
National	46.3	43.8	45.5	51.3	54.1	56.8
Rural	47.9	46.8	45.9	52.9	55.0	59.6
Urban	29.3	28.9	-	49.2	51.0	51.5
Nairobi	26.5	25.9	-	50.2	43.9	52.6
Central	35.9	31.9	32.3	31.4	31.1	35.3
Coast	43.5	55.6	55.8	62.1	57.6	69.9
Eastern	42.2	57.8	56.7	58.6	58.3	65.9
Nyanza	47.4	42.2	42.3	50.1	64.6	70.9
Rift Valley	51.5	42.9	41.4	50.1	47.9	56.3
Western	54.8	53.8	54.0	58.8	60.8	66.1
Geographic coverage	Half of districts	All districts	Same as WMSI	No North-Eastern	Poverty mapping	Same as WMSIII
Survey period	Nov-Dec	June-Aug		Apr-June	-	-
Relation to harvests	Pre-cereals	Cereals (Aug) Tea (June)		Pre-cereals Tea (June)	-	-
Climatic conditions	Poor	Favorable		El Nino	Average	Drought
CPI inflation for period	30%	30%		15%	5%	8%

Source: GK 2000; 2003a; Kimalu et al. 2002
Note: The 1999/2000 poverty rates are based on small area econometric estimates derived by combining the recent population census with the 1997 WMSIII. The 2000 rates are derived by updating the 1997 level and distribution of expenditures, based on changes in per capita growth from national accounts and projected Gini coefficients. CPI is the consumer price index.

Furthermore, all three surveys were conducted at different times of the year and so captured households at different stages of their annual income cycle. This is especially important for poor rural households whose agricultural incomes are seasonal. Therefore, while the surveys suggest that the share

of the population living below the national poverty line has risen from 46.3 percent in 1992 to 51.3 percent in 1997, such detailed comparisons are, strictly speaking, inappropriate. However, most social indicators also worsened during this period, which corroborates a rise in poverty (World Bank 2006).

Keeping the above limitations in mind, the surveys suggest that the rise in poverty has been concentrated in urban areas. This reflects rapid urbanization and slow industrial growth, which in turn explains the growth in private services typically associated with the informal economy. Conversely, the smaller rise in rural poverty may be attributed to agriculture's stronger performance and slower rural population growth. Regardless of whether poverty rose over the last 10 years, the level of poverty in Kenya remains high. Half of the population's incomes are insufficient to meet their basic needs. It is within this context of sluggish growth and severe poverty that the government designed its current strategy for economic recovery.

Kenya's Development Strategy

The Economic Recovery Strategy (ERS) outlines Kenya's current development objectives, which include restoring economic growth, generating employment, and reducing poverty (GK 2003b). The strategy indicates the expected contributions of each sector and the policies required to realize growth (Table 1). Under the ERS, Kenya is expected to follow an industry-led growth path, encouraged by a series of policy interventions and public investments. The ERS includes both the formal and the informal economies when describing the importance of trade and industry, although the policies identified in the strategy are geared more toward the formal sector. These include reducing bureaucratic delays; computerizing immigration, customs, and the registration of companies; negotiating trade protocols; and encouraging research and development through tax incentives. Policies for the informal sector include establishing "incubator zones" for small enterprises and supplying these with supporting infrastructure. It is hoped that reducing production costs and providing an enabling environment for renewed investment will allow the trade sector to grow at 11 percent per year. High industrial growth will require higher levels of investment and imports.[1] As such, while the economy is projected to grow at around 6.0 percent per year during the recovery period, household consumption expenditure is expected to grow more slowly at 4.7 percent. Since this is still substantially higher than both population growth and the country's past performance, it is expected that the level of poverty will have declined by at least five percentage points by 2007.

Agriculture is expected to grow at 3 percent per year under the policies and investments outlined in the ERS. For crop agriculture, these include expanding extension services, improving rural roads and

[1] The emphasis on industrial development may not necessarily imply that government *spending* should be biased toward this sector, since policies affecting private sector development and international trade may be less expensive to implement than infrastructure investments, yet cause significant increases in industrial growth.

irrigation, and strengthening farmer organizations. The livestock sector is also targeted through increased support for the dairy sector and improved animal health services. Emphasis is also placed on diversifying into new crops, such as cashew nuts, oil crops, and sorghum and cassava. Agricultural research is directed toward ensuring the potential of these new crops, while extension services facilitate the dissemination of new technologies to farmers. While it is hoped that these investments and policies can reverse the long-term decline in agricultural productivity, the ERS is not particularly optimistic about the sector's growth. This can be seen in the growth projection of 3 percent, which is simply a continuation of the sector's long-term growth performance. Critically assessing this perspective is important given the current role of agriculture in the Kenyan economy.

The Role of Agriculture

Agriculture is the largest sector in the Kenyan economy, generating a quarter of gross domestic product (GDP) and two-fifths of export earnings (Kiringai, Thurlow, and Wanjala 2006). Unlike many other African countries, agricultural production in Kenya is relatively diverse, with export crops and higher-value horticultural crops being as important as cereals and root and oil crops (see Table A1in the appendix). Exports include both traditional crops such as tea and coffee, as well as nontraditional crops such as cut flowers. By contrast, food crop production is dominated by maize and half of the country's rice and wheat is imported. Agriculture and food processing are especially important activities for the rural economy, generating two-thirds of rural GDP. Given that 85 percent of the population lives in rural areas, this implies that agriculture is the primary source of income for a majority of households. Furthermore, while crop incomes are less important for urban households, the livestock sector still comprises a tenth of the informal economy, which in turn provides employment for poorer urban workers.

Despite Kenya's diversity, the agricultural sector has experienced mediocre growth over the last two decades, thus mirroring the weak overall performance of the economy. Agricultural production grew at 1 percent annually during the 1990s, driven by marginal improvements in crop yields or productivity (FAO 2006). However, this growth was well below the population growth rate of 2.5 percent. Although agricultural growth has doubled since 2000, this more recent period has been characterized by rapid area expansion and stagnant yields. There is also variation in the performance of individual sectors. On the one hand, horticulture and export crops have grown rapidly over the last decade, with the exception of coffee due to a collapse in international prices. On the other hand, cereals and root crops performed poorly during the 1990s, and while these sectors have subsequently expanded production, they have continued to experience pronounced declines in yields. Given Kenya's growing population and land constraints, the key challenge for accelerating agricultural growth is overcoming the long-standing and widespread deterioration of farm productivity.

A number of studies have examined the determinants of agricultural productivity in Kenya.[2] Falling yields during the early 1990s are attributed to the poor sequencing of market reforms and subsequent declines in the use of fertilizer and hybrid seeds (Karanja, Jayne, and Strasberg 1999; Odhiambo, Nyangito, and Nzuma 2004). Recent evidence suggests that fertilizer use is rising rapidly, although this is concentrated in favored agrological regions (Ariga, Jayne, and Nyoro 2006). Furthermore, increased population pressure in these favorable regions has caused migration to less-favored lands where existing technologies are often inappropriate (Nyoro and Jayne 1999). Funding for agricultural research is insufficient for the development of more appropriate seed varieties (Odhiambo, Nyangito, and Nzuma 2004). Accordingly, increased spending on research and the provision of extension services is identified as a binding constraint to agricultural growth (Nyangito 1999). However, farmers' knowledge of improved inputs is already widespread, suggesting that market development may be as important as extension (Nyoro, Wanzala, and Awour 2001). This is because higher input prices and lower output prices reduce the incentive for small-scale farmers to purchase fertilizer and hybrid seeds (Owuor 1999). Therefore, increasing market access by investing in roads is considered complementary to enhancing on-farm technology. Furthermore, improved market access and commercialization are found to increase input use and yields for both food and cash crops (Strasberg et al. 1999). Productivity growth also depends on other forms of rural infrastructure, such as irrigation. Investments to improve water management have slowed dramatically over the last two decades, yet they remain fundamental for growth in some areas of the country (Odhiambo, Nyangito, and Nzuma 2004). Similarly, agricultural services that improve livestock management and disease control are found to have a positive impact on growth (Kabubo-Mariara 2001; Karanja 2003). Finally, the literature identifies access to credit and working capital as a constraint for rural households (Nyoro, Wanzala, and Awour 2001; Kibaara 2006). Therefore, extensive empirical evidence exists to identify the types of investments needed to enhance agricultural productivity and accelerate rural growth in Kenya.

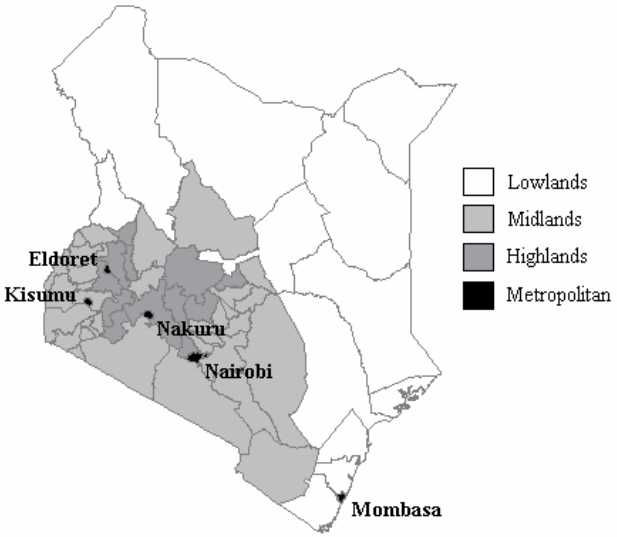
Regional Differences in the Agricultural System

A key finding from the literature on rural investment is that returns tend to vary across regions.[3] In order to capture how initial economic and environmental conditions influence the impact of rural investments, we divide Kenya into its three main agroecological regions: lowlands, midlands, and highlands (Figure 1). These regions include both rural areas and small towns. Major metropolitan centers are identified separately as cities and towns with more than 100,000 inhabitants. Although the five metropolitan centers in Kenya comprise less than 10 percent of the total population, they generate three-quarters of

[2] See Odhiambo and Nyangito (2003) for a review of the literature.
[3] See Fan and Rao (2003) for a review of the literature, and Fan, Zhang, and Rao (2004) for a Ugandan case study.

nonagricultural production and more than half of national GDP (Appendix Table A1). Linkages to agriculture are mainly through demand for intermediate inputs for food processing, since urban households consume processed food rather than agricultural products, and since metropolitan areas produce a surplus of processed food (Kiringai, Thurlow, and Wanjala 2006).

Figure 1. Kenya's agrological zones and metropolitan centers



Note: *Lowland*, *midland,* and *highland* refer to agroecological regions; *metropolitan* includes cities and towns with over 100,000 residents. Agrological zones are district-level resolutions based on the dominant agrological zone by unweighted land area.

Kenya's agrological regions differ considerably (Table 3). The lowland region has the largest land area but is sparsely populated, although most of the population lives near the coast rather than in the interior. The lowland region generates less than 5 percent of national GDP, and average per capita incomes are low at US$132 per year. This is reflected in the region's high poverty with three-fifths of the population falling below the official poverty line.[4] Despite better conditions along the coast, much of the lowland region is semi-arid with low average rainfalls. Access to assets and infrastructure are also poor, with low road densities, few cattle per capita, and long distances to piped water. Finally, only a quarter of farmers use fertilizer and improved seeds and few households engage in commercial agriculture, relying more on subsistence food production. In spite of its low level of development, agriculture generates less regional GDP in the lowlands than in either the midlands or highlands. However, pastoralists are a significant portion of the population, thus making the livestock sector an important component of the lowland economy. Therefore, given the poor initial conditions, improving food security is likely to be the key objective for lowland development.

[4] The poverty line per person per year was defined in the 1997 WMS as Kenyan shillings (Ksh) 21,848 (US$288) in rural areas and Ksh46,693 (US$615) in urban areas, both expressed in 2003 prices and unadjusted dollars.

Table 3. Regional characteristics

	Agrological region			Metro. centers	Kenya
	Lowlands	Midlands	Highlands		
Area (sq. km)	384,759	161,942	43,824	8,391	598,916
Population (1000s)	4,622	15,934	4,899	2,324	27,779
Population density (per sq. km)	12	98	112	277	46
GDP per capita (Ksh)	10,007	15,237	28,098	236,571	35,152
GDP per capita (US $)	132	201	370	3,117	463
Poverty incidence (P0) (%)	61.0	54.9	41.5	13.9	51.4
Depth (P1)	24.4	19.7	13.6	5.7	18.0
Severity (P2)	12.2	9.2	6.1	0.0	8.3
Share of maize farmers (%)					
Using fertilizer	22.2	81.4	86.0	-	64.9
Using improved seed varieties	26.4	87.5	82.8	-	67.7
Engaged in commercial activity	19.6	47.7	44.1	-	38.2
Maize fertilizer use (kg per acre)	7.0	46.3	77.4	-	50.4
Maize yield (Ksh per acre)	5,760	11,637	9,928	-	9,364
Rainfall (mm per year)	563	1,061	815	-	839
Distance to piped water (km)	10.4	9.1	4.0	-	8.0
Road density (km per sq km)	0.12	0.50	0.88	1.85	0.30
Number of cattle per household	1.0	1.5	2.2	0.0	0.8

Source: Own calculations using 1999 population census (GK 2000), 1997 WMS (GK 2000 and the 2003 Kenyan social accounting matrix (Kiringai, Thurlow, and Wanjala 2006). Population-weighted regional averages are calculated using information from Ariga, Jayne, and Nyoro 2006; Karanja, Jayne, and Strasberg 1999; Owuor 1999; and Strasberg et al. 1999.

The midlands is the main region for food crops, producing three-quarters of all cereals and root and oil crops in Kenya. Rainfall and maize yields are highest in this region, and a large share of farmers use fertilizers and hybrid seeds.[5] However, population density is eight times higher than in the lowlands and land scarcity is increasingly a constraint to growth (Nyoro and Jayne 1998). Livestock also forms an important part of the midlands economy, although, unlike the lowlands, dairy rather than cattle farming dominates because the midlands has better access to urban markets (Karanja 2003). Average incomes are higher and poverty is lower in the midlands than in the lowlands. However, the midlands' large share of the population implies that almost two-thirds of the poor live in this region. The regions' dependence on agricultural incomes and its favorable initial conditions suggest that reversing falling maize yields and encouraging cash crop production are key development objectives (Mose 1999).

Finally, agrological conditions are also favorable in the highlands region, where maize yields and annual rainfall are relatively high. As in the midlands, there is widespread use of improved inputs, although only half of farmers engage in commercial agriculture. Unlike other regions, the highlands is

[5] While the share of maize farmers using fertilizer and hybrid seeds is high in the midlands and highlands, their application rates are well below recommended levels. On average, fertilizer application among maize farmers in the lowlands, midlands, and highlands are 1.5, 72.8, and 56.3 percent of recommended levels, respectively.

heavily involved in higher-value horticulture and export crops and, despite its relatively small land area, is responsible for half of all production in these sectors. Accordingly, average incomes are higher and poverty is substantially lower in the highlands. Infrastructure is also more developed, with higher road densities and better access to water. Therefore, while the nature of investments may differ, the objectives for the highlands are similar to those of the midlands: encourage commercialization and increase cash crop production.

In summary, while recent growth has been more promising, the performance of the Kenyan economy over the last decade has not been strong enough to generate significant reductions in poverty. On the contrary, there is evidence that both poverty and inequality may have worsened. Both agricultural and industrial growth has been erratic, with periods of expansion followed by rapid slowing and even stagnation. In this context, the government has devised a strategy for economic recovery through industry-led growth. The strategy is less optimistic for agriculture, which is projected to continue growing at its long-term growth rate. However, despite regional differences, the agricultural sector plays an important role throughout the Kenyan economy, both as a source of growth and as a provider of employment and incomes for a majority of the population. In light of the diverging expectations placed on agriculture and industry in the country's development strategy, we now examine and contrast these alternative sources of growth and estimate their impact on poverty.

3. SEARCHING FOR SOURCES OF POVERTY-REDUCING GROWTH

In this chapter we use an economy-wide model to examine the impact of alternative sources of growth on poverty and inequality. Three sets of scenarios are presented. In the first scenario the model is calibrated to replicate the level and structure of growth that Kenya experienced over the last five years. Not only does this baseline scenario estimate the level of poverty that is likely to be achieved by 2015, but it also provides a counterfactual scenario for subsequent simulations. The second set of scenarios compares the poverty outcomes resulting from accelerating agricultural and industrial growth. These scenarios broadly assess the industry-led growth currently being advocated. Finally, a third set of scenarios looks within agriculture and estimates the poverty impact of accelerating growth in food crops and livestock, and export crops. These scenarios consider the effects of diversifying into nontraditional crops versus expanding domestic food production. These scenarios are designed to allow for a scale-neutral comparison of the poverty-reducing effects of alternative sectoral growth paths, without taking the cost of accelerating growth into account. This section therefore does not address how growth in different sectors can be achieved, which is the focus of chapter 4.

Modeling Alternative Growth Strategies and Their Impact on Poverty

Empirically estimating the relative importance of agriculture and industry in pro-poor growth requires an analytical method that isolates the effects of growth on poverty, while also incorporating the effects of structural change on the growth–poverty relationship. Accordingly, this section describes the dynamic computable general equilibrium (CGE) and microsimulation model that we use to analyze growth and distributional change in Kenya. Since the model and its database are described in detail in Kiringai and Thurlow (2006) and Kiringai, Thurlow, and Wanjala (2006), this section focuses on the key features of the model.

Our first objective is to capture how agriculture and industry contribute to economic growth. An important determinant is the growth linkages between each sector and the rest of the economy. Both own and marketed consumption (forward) and production (backward) linkages are captured in the CGE model, whose production functions allow producers to generate demand for both factors and intermediate inputs when maximizing profits. The model is calibrated to a highly disaggregated 2002 social accounting matrix (SAM) that distinguishes between 212 productive activities (53 sectors in four subnational regions) and 53 commodities (see Table A2 in the appendix). The regions include the three main agro-ecological zones (lowlands, midlands, and highlands) and the major metropolitan areas. However, while regional production structures and technologies are captured in the model, regionally produced commodities are traded in national and international markets. The model captures import competition and

export opportunities by allowing producers and consumers to shift between domestic and foreign markets depending on changing relative prices. The model identifies 39 factors of production, including region-specific capital, land, and labor. Labor is also disaggregated by gender and occupational skill categories. Both capital and labor are disaggregated across rural, urban informal, and urban formal sectors, forming the basis for the nesting of factor demand. Land and skilled labor are fully employed, earn flexible returns under fixed supply, and are mobile across sectors within regions. Unskilled labor faces unemployment, earns a fixed real wage, and is mobile across both sectors and regions. By contrast, existing capital is immobile earning flexible activity-specific returns. This detailed specification of production and factor markets allows the model to capture the changing scale and technology of production across sectors and regions, and therefore, the way that changes in Kenya's growth structure influence its distribution of incomes.

Our second objective is to capture the contribution of agriculture and industry to household livelihoods. Income and expenditure patterns vary considerably across households, especially across regions and rural and urban areas. These differences are important for distributional change, since the incomes generated by agriculture and industry will accrue to different households depending on their location and factor endowments. To capture these differences, the model distinguishes between 70 representative households, each of which is an aggregation of a group of households in the 1997 Welfare Monitoring Survey (WMSIII). Households in the model earn monetary and nonmonetary incomes, and, after paying taxes, use their disposable income to consume commodities. In order to retain as much information on households' income and expenditure patterns as possible, the CGE model is linked to a microsimulation module based on WMSIII. Endogenous changes in commodity consumption for each aggregate household in the CGE model are used to adjust the level of commodity expenditure of the corresponding households in the survey. Real consumption levels are then recalculated in the survey and standard poverty measures are estimated using this updated expenditure measure.

The model makes a number of assumptions about how the Kenyan economy maintains macroeconomic balance. These "closure rules" concern the foreign or current account, the government or public sector account, and the savings–investment account. For the current account, a flexible exchange rate maintains a fixed level of foreign savings. This assumption implies that Kenya cannot increase foreign borrowing but has to generate export earnings in order to pay for food or capital imports. While this assumption realistically limits the degree of import competition in the domestic market, it also underlines the importance of the agricultural and industrial export sectors. For the government account, public expenditures are exogenously determined and the government adjusts private tax rates in order to maintain a fixed fiscal deficit. For the savings–investment account, real investment adjusts to changes in savings (savings-driven investment). These assumptions allow the model to capture the negative

crowding-out effects of public expenditures on private consumption according to the current tax-incidence.

Finally, the CGE model is recursive dynamic, which means that key parameters in the model are updated each period based on previous period results. The model is run over the 13 years (2003–15) with each equilibrium period representing a single year. During this time the model captures exogenous demographic and technological change. Changes in the population, labor supply, human capital, and total factor productivity (TFP) are based on observed trends and available literature.[6] By contrast, capital accumulation is endogenous, with previous-period investment generating new capital stock. Although the allocation of new capital is influenced by each sector's initial share of gross operating surplus, the final allocation depends on depreciation and sector profit-rate differentials. Sectors with above-average returns in the previous period receive a larger share of the new capital stock in the current period. Although the model runs during 2003–15, deviations in sectoral growth rates and public investment take place during 2006–15.

In summary, the model captures distributional and poverty impacts by (1) disaggregating growth across regions and sectors; (2) capturing employment effects through factor markets and price effects through commodity markets; and (3) translating these two effects onto each household in the survey, according to its unique factor endowment and income and expenditure patterns. This allows for the model to capture the poverty impacts associated with growth in agriculture and industry in Kenya.

Poverty Reduction Under the Current Growth Path

Under the baseline scenario, Kenya is assumed to grow at an annual rate of 3 percent (Table 4). This is slightly higher than what was experienced during the previous seven years, but is consistent with the acceleration of growth since 2000. This aggregate level of growth is achieved by calibrating sectoral growth rates to track recent trends.[7] Therefore, assuming past trends persist, agriculture in the model grows more rapidly than overall GDP growth at 3.3 percent, driven by the strong performance of cash crops and livestock. By contrast, food crops grow slowly and food processing in the manufacturing sector stagnates. The combined growth in food production is below the population growth rate of 1.9 percent, implying that national per capita food production falls. However, population growth in rural areas is lower than in urban areas, meaning that the food deficit falls more heavily on urban households.

[6] See Table A3 in the appendix for the assumptions made in calibrating the dynamics of the model.

[7] The sectoral growth target is attained by exogenously increasing TFP to supplement endogenously determined labor supply and capital accumulation. The overall required TFP growth in the baseline scenario is 0.7 percent per year for 2006–15. This is higher than the –0.96 percent overall TFP growth estimated by Ndulu and O'Connell (2003) for 1995–2000, but lower than the 1.7 percent from Onjala (2002) for 1986–1995.

Table 4. Growth outcomes under growth scenarios

	GDP share 2003	Average annual growth rate (%)						
		Actual data 1997-04	Simulation results, 2006-15					
			Base-line	Industry -led	Agric.-led	Food crops	Live-stock	Export crops
GDP factor cost	100.0	2.6	3.0	4.0	4.0	4.0	4.0	4.0
Agriculture	23.5	3.3	3.0	2.8	7.0	7.2	6.5	7.4
Cereals	2.9	2.1	2.5	3.3	4.3	5.7	2.6	1.9
Roots & tubers	3.1	0.9	0.9	1.4	3.0	7.9	0.9	-1.2
Horticulture	3.7	3.4	4.0	4.3	7.5	21.2	4.2	-0.1
Export crops	6.1	5.5	4.0	1.8	10.5	-11.0	5.5	16.3
Livestock	6.6	2.8	3.0	3.6	6.0	3.1	11.6	3.7
Industry	21.2	2.1	2.8	6.4	2.3	2.3	3.0	1.9
Manufacturing	12.4	0.8	2.2	6.5	1.2	1.2	2.4	0.1
Food processing	4.2	0.2	1.0	3.4	1.1	0.7	1.8	0.6
Light industry	2.0	1.7	1.5	6.4	-0.1	0.0	1.3	-1.1
Heavy industry	6.2	0.3	3.2	8.2	1.6	1.8	3.1	0.2
Private services	42.7	3.2	3.3	3.9	3.5	3.4	3.5	3.5
Public services	12.6	1.9	2.0	2.0	2.0	2.0	2.0	2.0
GDP factor cost	-	-	3.0	4.0	4.0	4.0	4.0	4.0
Labor employment	-	-	0.9	0.9	0.9	0.9	0.9	0.9
Capital and land	-	-	1.4	1.7	1.5	1.4	1.4	1.5
TFP	-	-	0.7	1.5	1.7	1.7	1.7	1.7

Source: Kenyan CGE/ microsimulation model and observed trends from national accounts (GK 2006)
Note: *Food crops* include all edible crops (such as cereals, roots, pulses); *cash crops* include both export and industrial crops (such as cut flowers, tea, horticulture, tobacco); *light industry* includes textiles, clothing, and wood and paper products; and *heavy industry* includes chemicals, petroleum, and machinery and equipment.

The baseline scenario assumes a more balanced structure of growth than was experienced during 1997–2004. Manufacturing grows at 2.2 percent per year during 2006–15. This acceleration of manufacturing growth is in line with more recent trends and the observed investment growth. Investment growth generates particularly strong demand for both heavy industry and construction, whose production and imports expand accordingly. Services also continue along past trends, with private and public services growing at 3.3 and 2.0 percent per year respectively.

While the economy grows at 3 percent per year, household consumption expenditure rises by only 2.8 percent per year or 0.9 percent in per capita terms. This is higher than the per capita consumption growth experienced during the 1990s, and reverses previous increases in poverty. Under the baseline scenario, the national incidence of poverty falls from 51.3 percent in 2003 to 48.1 percent in 2015 (Table 5). However, this aggregate decline hides the continued rise in urban poverty that began during the 1990s. The share of the urban population falling below the national poverty line increases from 47.6 percent to

49.5 percent. By contrast, rural poverty falls by more than four percentage points. This implies that, if the current growth path is maintained, urban poverty will be higher than rural poverty by 2015.[8]

Table 5. Poverty outcomes under growth scenarios

	Pop. 2003	Poverty 2003	Baseline	Industry-led	Agric.-led	Food crops	Live-stock	Export crops
			Final year poverty rate in 2015 (%)					
National incidence (P0)	100.0	51.3	48.1	46.0	38.7	39.3	41.6	39.9
Rural	84.3	51.9	47.8	45.8	36.7	37.4	40.1	37.9
Urban	15.7	47.6	49.5	46.8	48.6	47.9	48.8	49.8
Lowland	6.3	61.0	60.0	57.6	55.0	53.6	58.7	54.3
Midland	59.5	54.7	51.8	49.8	40.0	40.8	44.1	41.9
Highland	22.2	41.4	34.3	31.4	24.9	26.1	25.9	25.2
Metropolitan	11.9	47.1	48.3	47.2	47.9	47.0	47.9	48.7
National depth (P1)	-	17.9	18.0	16.6	12.8	13.4	15.0	13.1
National severity (P2)	-	8.2	8.7	7.9	5.7	6.1	7.1	5.9
			Poverty-growth elasticities, 2006-15					
National incidence (P0)	-	-	-0.17	-0.51	-2.20	-2.13	-1.58	-1.90
Rural incidence	-	-	-0.22	-0.45	-2.66	-2.46	-1.90	-2.36
Rural gap	-	-	-0.16	-0.57	-4.22	-3.72	-2.51	-4.32
Rural squared gap	-	-	-0.11	-0.57	-5.32	-4.53	-2.84	-5.66
Urban incidence	-	-	0.10	-0.78	-0.23	-0.66	-0.18	0.15

Source: Kenyan CGE-microsimulation model
Notes: The microsimulation module is based on the 1997 WMS (GK 2000) thus initial poverty rates in the model are those for 1997. The official basic needs poverty line is set at Ksh1, 239 (rural) (US$21) and Ksh2, 648 (urban) (US$45) per adult per month (1997 prices).

The baseline scenario suggests that not all households will benefit equally under Kenya's current growth path. One measure of the effectiveness of growth at reducing poverty is the poverty-growth elasticity (Ravallion and Chen 2003). Under the baseline scenario, the poverty-growth elasticity for the national incidence of poverty is –0.38 (cf. Table 5). This means that every 1.00 percent growth in per capita GDP leads to a 0.38 percent decline in the poverty rate.[9] This elasticity incorporates the effects of a changing distribution of incomes and is therefore a *dynamic* measure of the growth–poverty relationship. The model is also used to estimate the economy-wide growth rate that would be required to achieve the first MDG of halving 1992 poverty by 2015 (that is, 22.2 percent). Assuming all sectors grow proportionately, the required annual GDP growth rate is 10.3 percent during 2006–15. Since few countries have achieved and sustained such high growth, Kenya will inevitably fall short of this development goal. However, these calculations assume that growth will continue to be as effective at reducing poverty. Therefore, while accelerating economic growth is undoubtedly a most pressing

[8] Kenya has separate expenditure-based poverty lines for rural and urban areas, reflecting the higher cost of living for urban households. Higher urban poverty therefore does not mean that nominal rural incomes are higher than urban incomes. Furthermore, this study uses expenditure-based poverty and so does not capture asset deprivation.

[9] Note that this is a percent decline rather than a percentage point decline.

objective, the government should also seek ways to ensure that a greater number of Kenyans participate in the growth process. With this objective in mind, the next section compares growth in agriculture and industry-led growth.

Comparing Agriculture and Industry-Led Growth

The impact of agricultural and industrial growth on poverty is examined by accelerating the overall GDP growth rate from its current 3 percent to 4 percent per year. Two scenarios are presented in which the source of this additional growth differs. In the agriculture-led scenario, growth in the agricultural and food processing sectors is increased, while additional growth in the industry-led scenario comes from mining, nonfood manufacturing, and construction. Although the two scenarios generate the same overall GDP growth rate, the required increases in sectoral growth are different due to their relative sizes and growth linkages. For instance, under the agriculture-led scenario, the growth rate of agriculture increases from 3.3 percent; under the baseline scenario, it increases to 7 percent, while manufacturing growth declines slightly (Table 4). Falling manufacturing growth indicates that resource competition with the agricultural sector outweighs the positive income effects caused by faster agriculture-led growth. Conversely, under the industry-led scenario, manufacturing growth increases from 2.2 to 6.5 percent per year, while agricultural growth decreases slightly.

By assumption, faster agricultural growth in the agriculture-led scenario is driven by food and export crops, livestock, and forestry and fishing. However, the model suggests that export crops would grow faster than other agricultural subsectors due to better foreign market opportunities and hence smaller declines in domestic prices after production has expanded. Agricultural production directly raises incomes among rural households, and it indirectly raises real incomes among urban and rural households through reduced food prices. Therefore, the incidence of both rural and urban poverty declines, although it is more heavily concentrated among rural households (Table 5). Rising incomes and expenditures are particularly pronounced in the poorest populations, as seen by the larger decline in both the depth and severity of poverty. Therefore, while all households benefit from faster agricultural growth, it is the poorer rural households that benefit the most.

By contrast, the benefits of faster nonfood manufacturing growth in the formal and informal sectors under the industry-led scenario are more concentrated among the less-poor households. While faster growth in the labor-intensive light industry and construction sectors does benefit poorer urban households, poverty under the industry-led scenario declines only slightly more than under agriculture-led growth. This is because poor urban households are less likely to be employed in the more formal mining and heavy manufacturing sectors and hence only benefit indirectly through higher economy-wide growth in the informal service sectors. However, the overall effect of accelerating growth in light manufacturing

and construction and the spillover into services is enough to ensure that the informal economy grows alongside the formal economy. This drives the decline in urban poverty but limits any positive spillovers to rural households.

One of the arguments put forward by the proponents of agriculture is that the sector has sufficient scale to generate significant economy-wide growth (Diao et al. 2006). For example, in the case of Kenya, agriculture and food processing generate 28.1 percent of GDP, while mining and nonfood industry generates 17.5 percent. Therefore, since a 1.0 percent increase in agricultural GDP is larger than a 1.0 percent increase in industrial GDP, it might seem trivial to suggest that agricultural growth is better at reducing poverty. However, the above scenarios are "scale-neutral" since the same aggregate GDP growth rate was targeted in each of the scenarios. Therefore, the results suggest that it is not only agriculture's large share of GDP that determines its ability to generate broad-based poverty reduction, but also its particular ability to generate employment and incomes among the poor population.

Agriculture's proponents also emphasize the sector's strong growth linkages to the rest of the economy. Agricultural growth generates growth in both rural and urban areas, although it is more strongly linked to the urban informal economy than to the more formal manufacturing sectors. Beyond the competition over resources described earlier, the weaker linkages between agricultural and formal manufacturing growth is primarily due to rural demand patterns. Rural households are the direct beneficiaries of agricultural growth, yet they demand fewer formal sector goods than urban households. Therefore, when agriculture grows more rapidly it does not generate much demand for formal manufacturing goods, although it does benefit the urban economy by lowering food prices. However, despite some negative spillover effects, agriculture has stronger growth linkages than industry. Agriculture's GDP multipliers are larger than those of industry and similar to those of services (Table 6). Furthermore, agriculture's income multipliers are larger than those of services, suggesting that agriculture-led growth is better at generating employment and raising incomes. The CGE model's results also indicate that agriculture's economy-wide growth linkages are more pro-poor. Under the agriculture-led scenario, the national incidence of poverty falls to 38.7 percent, compared to 46.0 percent under the industry-led scenario. This difference implies that there would be 2.5 million fewer people living in poverty by 2015. Although the additional 1 percent growth is insufficient to halve poverty by 2015, accelerating agricultural growth from 3.3 to 7.0 percent is enough to achieve half of the MDG, whereas the equivalent industrial growth meets only a fifth of the target. This means that agriculture-led growth is more than twice as effective at reducing poverty as industry-led growth. This can be seen by comparing the poverty-growth elasticity of the agriculture-led scenario with that of the industry-led scenario (Table 5).

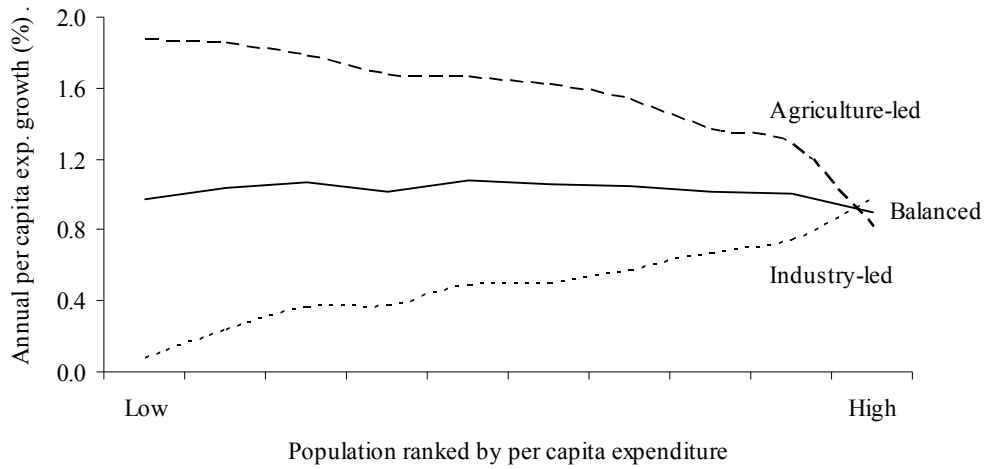
Table 6. Sectoral growth multipliers

	Multiplier after increasing sectoral output by 1 shilling		
	Output	**GDP**	**Income**
Agriculture			
Cereals	4.85	2.39	2.18
Roots & tubers	5.21	2.67	2.33
Horticulture	5.15	2.68	2.35
Export crops	5.16	2.62	2.32
Livestock	4.79	2.54	2.15
Industry			
Food processing	4.05	1.76	1.55
Light industry	4.25	1.87	1.67
Heavy industry	3.98	1.87	1.76
Construction and energy	4.59	2.11	1.81
Services			
Trade	4.63	2.24	1.87
Transport	4.78	2.32	2.03
Other private services	4.44	2.40	1.99
Public services	4.78	2.50	2.13

Source: Authors' calculations using the 2003 Kenyan social accounting matrix (Kiringai, Thurlow, and Wanjala 2006)
Note: Multipliers are unconstrained, thus assuming perfectly elastic supply and fixed prices.

Although agricultural growth is more effective than industrial growth at reducing national poverty, both sources of growth favor different groups and regions within the country. Faster industrial growth raises the poverty-growth elasticity in urban and metropolitan areas where households generate most of their incomes from nonfarm activities. Conversely, agricultural growth is most effective at reducing poverty in the regions where farm incomes are most important. Unlike industry, however, agricultural growth reduces poverty in all regions and among the country's poorest population (that is, the gap between elasticities is even larger for the depth and severity of poverty). These distributional effects are more clearly seen using national growth incidence curves (Figure 2). These curves show the additional per capita expenditure growth for each percentile of the population ranked according to expenditure levels. Under the balanced growth scenario the curve is always positive, implying that poverty is unambiguously declining. Furthermore, the curve is horizontal, indicating that per capita expenditure increases equally for both high- and low-income households. This means that inequality remains unchanged. By contrast, the growth incidence curve under industry-led growth is upward sloping, indicating that expenditure for low-income households rises less than that for higher-income households. While industrial growth exacerbates inequality, the opposite is true for agricultural growth whose curve is downward sloping. Perhaps most important, however, the growth incidence curve for agriculture-led growth is always above that of industry-led growth, implying that all households are likely to benefit more from agricultural growth. This is because industrial growth is more capital-intensive and investment-driven, thus leading to lower growth rates in private consumption spending.

Figure 2. Growth incidence curves under growth scenarios



Source: Kenyan CGE-microsimulation model
Note: Per capita expenditure growth is in addition to that experienced under the baseline counterfactual scenario.

This set of scenarios finds that differences in the sectoral structure of growth can have significant implications for poverty reduction. Increasing the rate of growth may be insufficient to significantly reduce poverty if growth generates distributional changes that isolate the poor from the growth process. The results for the industry-led scenario are similar to the projected structure of growth under the Economic Recovery Strategy (ERS). Therefore, given its focus on industrial growth, the ERS may produce poverty outcomes similar to the industry-led scenario presented above. Moreover, industry-led growth worsens income inequality, which is already high in Kenya. However, while agricultural growth may be more pro-poor than industrial growth, no single source of growth is equally effective at reducing poverty in all areas and regions of the country. Nor should the benefits of agricultural or industrial growth be seen to affect only rural and urban households respectively. In the case of Kenya, industrial growth linkages generate positive spillovers to the rural nonfarm economy, while agriculture's growth linkages raise real urban incomes, especially in the informal economy. Agricultural and industrial growth are therefore not mutually exclusive. However, agricultural growth should receive greater emphasis in Kenya's growth strategy if the country is to achieve more equitable outcomes. Accordingly, the rest of this paper focuses on accelerating growth within the agricultural sector.

Decomposing the Contribution of Agriculture

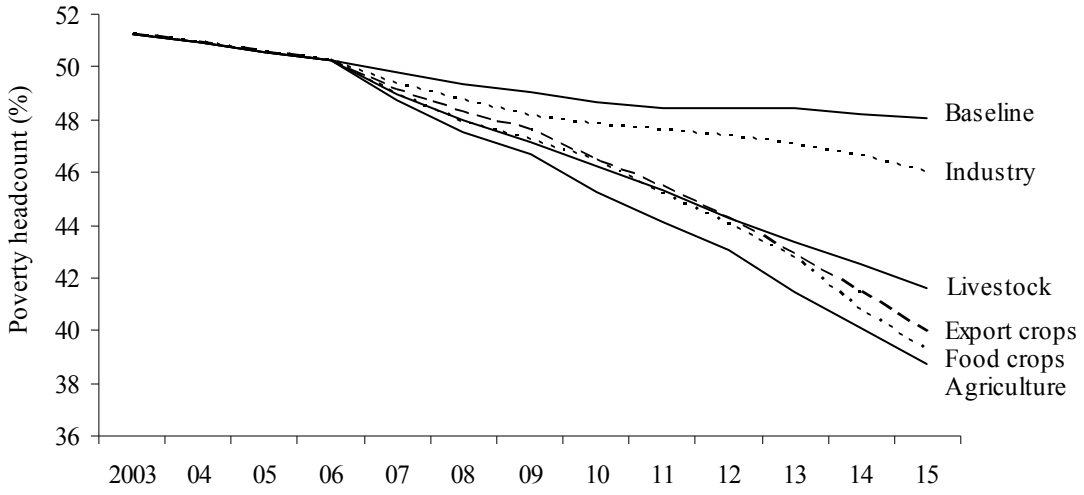
In this section, we look inside Kenya's agricultural development strategy and decompose the potential contribution of different agricultural subsectors to growth and poverty reduction (food crops, livestock, and export crops). The effectiveness of these subsectors in reducing poverty is again examined by raising the overall GDP growth rate from 3 to 4 percent through increases in TFP. Three scenarios are presented

in this section: (1) accelerated growth in food crops, (2) accelerated growth in the livestock and dairy sectors, and (3) accelerated growth in export crops. In these simulations, food crops include maize, sorghum, and millet; export crops include traditional and nontraditional crops such as tea, cotton, coffee, and horticulture; and livestock includes beef, poultry, dairy, and other livestock-related activities. Understanding the contribution of these subsectors to poverty-reducing growth is especially important for Kenya, whose agricultural growth in recent years has been characterized by a more rapid expansion in export crops and livestock but more modest growth in food crops and processing.

Agriculture's overall growth rate under the food crop scenario increases from 3.0 to 7.2 percent in order to generate the additional 1 percent in overall GDP growth (Table 4). The additional agricultural growth is higher under the export crop scenario, and the effect of rapidly rising agricultural exports is an appreciation of the real exchange rate, which undermines the competitiveness of other agricultural and manufacturing exports. Manufacturing growth therefore declines significantly under the export crop scenario. However, despite improved agricultural productivity, rapid growth in food crops creates greater competition for agricultural resources, especially land and rural labor, and this reduces the availability of these resources for other agricultural sectors. Accordingly, export crop growth reverses from 4 percent under the baseline scenario to –11 percent under the food crop scenario. Therefore, there is definite competition over resources between food and export crops. Shifts in the composition of agricultural growth also influence how households benefit from growth. These differences remain small at the national level, with food crop growth generating slightly better poverty outcomes than growth in export crops (Figure 3). However, at the subnational level there are more significant differences, with the lowland and midland regions benefiting more from food crop expansion than the highlands, which in turn benefits more from export crops.

Accelerating livestock production under the livestock scenario does not lead to pronounced resource competition with other agricultural sectors. Growth in the dairy sector favors the highland region. However, the impact on poverty resulting from accelerated livestock growth is smaller than under either food or export crop growth, especially for the depth and severity of poverty. This is evident in the relative sizes of the poverty-growth elasticities (Table 6). While all three scenarios have large elasticities, it is food crop production that strengthens the growth–poverty relationship the most. However, while this is true for the lowland and midland regions, it is not true for the highland region, where the growth–poverty relationship is weakened by an expansion of food crops (that is, at the expense of cash crops). By contrast, households in the highland region benefit more under the cash crop and livestock scenarios, albeit at the expense of lowland growth and poverty. Therefore, while the previous section found that agricultural growth is more pro-poor than industrial growth, there is still trade-offs within agriculture that can result in significant distributional changes.

Figure 3. Changes in poverty under growth scenarios, 2003–15



Source: Kenyan CGE-microsimulation model

In summary, a growth strategy that seeks to share the benefits of growth among households throughout the country cannot focus agricultural growth only in certain sectors. Such a narrow approach may successfully reduce poverty in the short term as incomes rise for households in those regions with appropriate conditions. However, national poverty reduction would taper off, since households in the less-favored regions are effectively isolated from the growth process. This is especially true for the lagging lowland region. Promoting only certain sectors without considering distributional change and regional differences can effectively exclude sections of the population from the benefits of growth. It should also be noted that the growth rates that would be required from export crops and horticulture were they solely responsible for generating additional GDP growth are unrealistically high at about 10 percent per year. Therefore, over and above the need to generate broad-based agricultural growth to ensure regional equity, it is unlikely that a strategy based on a single sector will be able to generate the levels of growth necessary to significantly raise growth and reduce poverty.

4. INVESTING IN AGRICULTURAL GROWTH

Public Spending and Agricultural Productivity

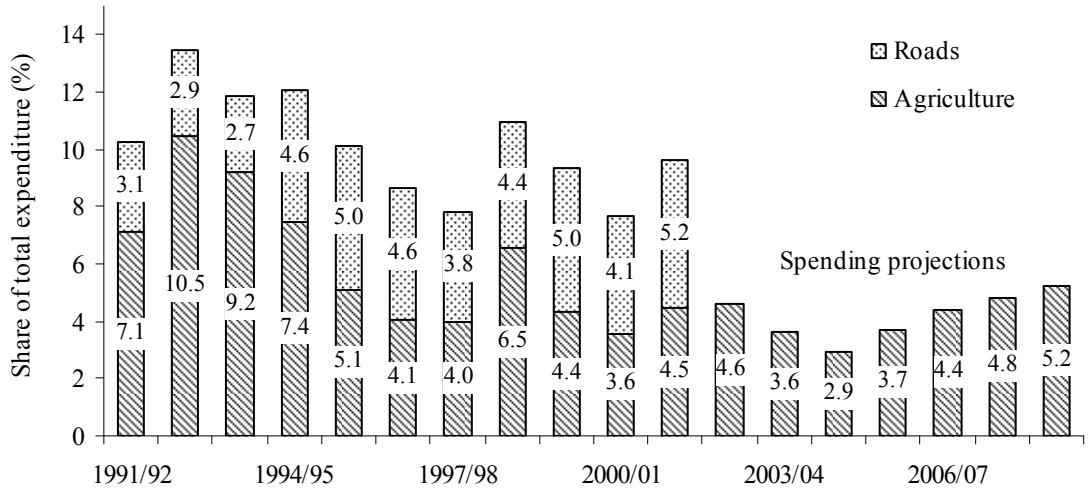
So far we have identified agriculture as an effective source of poverty-reducing growth. Next we consider how public investments can be used to accelerate agricultural growth, taking into account fiscal implications. Although there are many necessary interventions, there is some consensus within the empirical evidence. Given the constraints to area expansion in Kenya, policies should focus on raising agricultural productivity (Nyoro and Jayne 1999). The empirical evidence suggests that a number of binding constraints have lowered agricultural productivity. These include poor access to credit and farm capital (Ekborm 1998); low usage of farm inputs, especially fertilizer (Odhiambo, Nyangito, and Nzuma 2004; Nyoro and Jayne 1999); and a lack of technical knowledge among smallholders that has limited the use of pesticides and other farm inputs (Evenson and Mwabu 1998; Nyangito 1999). These constraints emphasize the need for extension services over and above rural education, whose relationship to agricultural productivity is found to be relatively weak (Odhiambo, Nyangito, and Nzuma 2004). Most important, increased investment in agricultural research has a strong and positive relationship to agricultural productivity. Supporting research is therefore especially important in Kenya, where increased land density has forced smallholder farmers to transfer inappropriate technologies into new environments (Nyoro and Jayne 1999). Taken together, improved inputs and technologies can reverse the long-run decline in the country's agricultural productivity. Finally, lowering Kenya's high transport costs through improvements in rural infrastructure, especially roads, is not only important for improving access to input and output markets, but it is also found to indirectly enhance the productivity of nontraded crops.

Empirical studies have found that government spending on agriculture has a positive impact on agricultural productivity (Odhiambo, Nyangito, Nzuma 2004). However, agricultural spending has fallen dramatically, having peaked around 10 percent in the early 1990s and dropping below 5 percent in more recent years (Figure 4). Government projections indicate that agricultural spending will gradually increase its share of budget allocations over the next five years but its share will remain around 5 percent. This mirrors the emphasis of the country's current development strategy but contrasts with the 10 percent expenditure target that the government committed to under the Maputo Declaration. Expenditure on roads has increased slightly, but while it is impossible to isolate rural roads from the figure, it is reasonable to conclude that total expenditure on agriculture and rural infrastructure has declined over the last decade.

In this chapter, we consider the impact and fiscal implications of increasing agricultural spending to 10 percent of the budget. Drawing on recommendations from the Kenyan literature, we explore two potential areas of investment within the agricultural sector. These include raising expenditure on research and extension and on irrigation and water management. Although the Maputo Declaration refers

specifically to agricultural spending, we also examine the impact of increasing investment in road infrastructure and strengthening market development. To estimate these impacts, we extend the CGE model to capture the relationship between spending and agricultural productivity.

Figure 4. Public spending on agriculture and roads, 1991–2009



Source: IMF statistical appendixes (various years) and projections from the Government of Kenya (various sources cited in Akroyd and Smith 2007)

Modeling the Impact of Rural Investments

Modeling the impact of investments takes place in two stages. First, a set of equations is specified that captures the channels through which specific investments affect agricultural productivity. The initial estimates of key parameters are drawn from the literature. Second, the productivity equations are integrated within the CGE model to capture the impact of increasing agricultural productivity on regional production and incomes, relative prices, resource allocations, and market constraints.

The impact of investments on productivity is modeled using a set of nested linear equations. As described earlier, the CGE model contains production functions for each sector in each region. Equation 1 is a production function in which producers combine labor L and capital K in order to produce total output Q in year t. Intermediate inputs are combined with factor value-added under a fixed share Leontief specification (that is, cheaper inputs reduce the cost of production but cannot substitute for factor inputs).

$$Q_t = \alpha_t F\left(L_t, K_t\right). \qquad (1)$$

As described earlier, demand for factor and commodity inputs is determined endogenously in the CGE model according to changes in relative factor and commodity prices. Rural investments affect the exogenous shift parameter α_t, which is a measure of TFP. This is shown in equation 2:

$$\frac{\dot{\alpha}_t}{\alpha_{t-1}} = \beta_0 + \beta_1 \frac{\dot{R}_{t-1}}{R_{t-2}} + \beta_2 \frac{\dot{I}_{t-1}}{I_{t-2}} + \beta_3 \frac{\dot{E}^e_{t-1}}{E^e_{t-2}}, \quad (2)$$

where R is the length of roads in kilometers, I is land under irrigation in hectares, and E^e is government expenditure on research and extension (R&E) in millions of Kenyan shillings. The β coefficients show the percentage change in TFP resulting from a 1 percent change in each of these investments. The right-hand terms of equation 2 are a combination of two stock variables (roads and irrigation) and a flow variable (R&E). We translate changes in public expenditures on roads and irrigation into changes in the stocks of these assets. This is done in equations 3 and 4

$$\dot{R}_{t-1} = \frac{R^e_{t-1}}{r} \text{ and} \quad (3)$$

$$\dot{I}_{t-1} = \frac{I^e_{t-1}}{i}, \quad (4)$$

where R^e and I^e are government expenditure on roads and irrigation in Kenyan shillings, and r and i are the unit costs of building one kilometer of feeder roads and one hectare of irrigation.

Four pieces of information are needed to calibrate the investment functions: (1) initial government expenditures (R^e, I^e, and E^e); (2) initial capital stocks (R and I); (3) investment elasticities (β); and (4) unit costs for stock variables (r and i). The values used are based on estimates from the literature and government sources. District-level road stocks from government sources were used to compile region-level stocks. Irrigation stocks in each region were derived from information on the national share of irrigated land for each crop weighted by regional cropping patterns. Unit cost information is taken from government sources, which estimate the cost of one kilometer of feeder roads at Ksh59,000 (US$750) and one hectare of irrigation at Ksh79,000 (US$1,000) both in 2002 prices.[10] It is assumed that these unit costs are the same throughout the country.

Estimates for the productivity-investment elasticities are based on econometrically estimated coefficients for Uganda (Fan, Zhang, and Rao 2004). These coefficients are allocated to crop categories or sectors (Table 7). It is assumed that elasticities are the same across regions. However, the returns to expenditures vary by region according to economic structures and initial expenditures and capital stocks. Of course, elasticities are not strictly speaking transferable across countries. In light of Kenya's own circumstances, we use a lower elasticity for R&E than was found for Uganda because there is evidence that extension services in Kenya are not as effective as elsewhere (Gautam and Anderson 1998). We use a higher initial elasticity for roads because Kenya has a more extensive road network than Uganda, and

[10] As with irrigation, unit costs include workers' wages and materials.

hence percentage stock changes are substantially larger in absolute terms. Since the returns to irrigation were not estimated in Uganda, we assume an initial elasticity for irrigation stocks. However, given the uncertainty associated with each of these elasticities, we conduct sensitivity analysis assuming a 25 percent confidence interval around initial estimates. These are shown in the table as upper and lower bounds.

Table 7. Elasticities in the productivity-investment function

Investment type	Productivity-investment elasticity				Sectors affected
	Uganda	Lower	Initial	Upper	
Roads	0.139	0.113	0.150	0.188	Crops, livestock, food processing, and trade
Irrigation	-	0.150	0.200	0.250	Crops (excl. highlands)
Extension	0.189	0.113	0.150	0.188	Crops (excl. export crops), and livestock

Source: Uganda estimates from Fan, Zhang, and Rao (2004). Upper and lower estimates are used for sensitivity analysis and are based on a 25 percent confidence interval around the initial estimate.

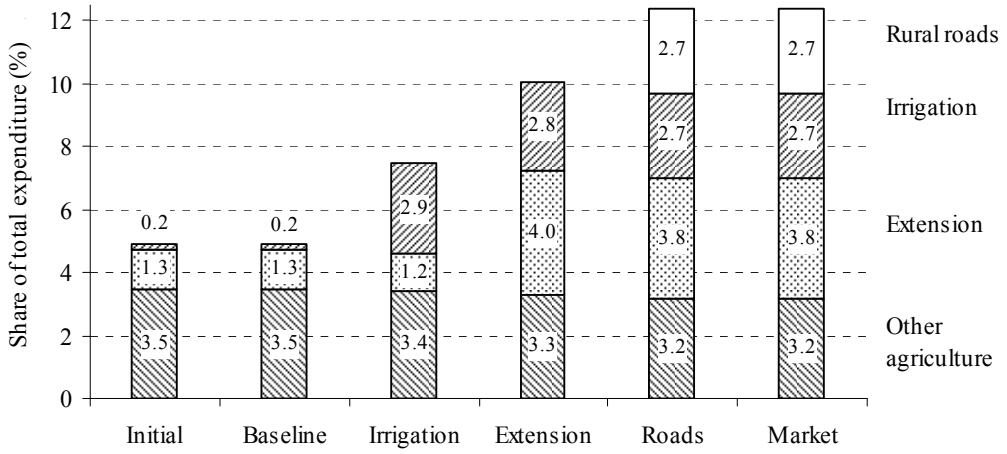
Government expenditures are already captured inside the CGE model, which tracks how revenues are raised through various taxes and then allocated across regions and government functions (health, education, agriculture, and roads, for example). District-level expenditure information from government sources and labor income from the WMSIII (GK, 2000) were used to disaggregate the government sector by function and region. The growth rate of public expenditures in the CGE model is determined exogenously for each government function. In the baseline scenario, all expenditures grew at the same 2 percent annual growth rate. However, in the investment scenarios that follow we increase the growth rate of each expenditure item in order to achieve expenditure share targets by 2015. In other words, additional agricultural spending is not at the expense of other expenditure items, but through higher overall spending by the government. The revenues needed to finance this additional spending are generated by increasing direct taxes on household incomes so that the government budget remains unchanged.

Increasing Spending on Irrigation and Extension

The literature identifies irrigation and water management, and R&E as areas where additional investments are needed to raise agricultural productivity. The first two investment scenarios assess these investment options. In determining the financial resource envelope for each scenario, we start with the initial share of total agricultural spending, which was equal to 4.8 percent of government spending in 2002 (Figure 5). This share comprised 0.2 percent on irrigation and 1.3 percent on R&E; the remaining 3.5 percent was on other areas of agriculture. Since all expenditure areas grew at 2 percent per year under the baseline scenario, there was no change in the final composition of total expenditure. However, in the irrigation scenario we gradually increase the share of government expenditure on irrigation from 0.2 to 2.7 percent during 2006–15. In the extension scenario we also increase the share of R&E spending by 2.7 percent so

that agricultural spending as a whole is 10 percent of total spending. This scenario is equivalent to meeting the expenditure target identified in the Maputo Declaration. It is important to note that the scenarios are cumulative, meaning that the extension scenario includes the effects of the irrigation scenario. Therefore, the counterfactual for the extension scenario is the irrigation rather than the baseline scenario.

Figure 5. Final agricultural expenditure shares under investment scenarios, 2015



Source: Kenya CGE/ microsimulation model
Note: Outcomes are cumulative (for example, roads include the expenditures from i*rrigation* and *extension*).

Increasing irrigation's share of total spending from 0.2 to 2.9 percent is equivalent to increasing the share of irrigable land under irrigation from 5.3 percent to 19.3 percent during 2006–15.[11] Under the baseline scenario, the share of land under irrigation would have risen to 6.9 percent. So in the irrigation scenario we are more than doubling the amount of irrigated land, or adding 180,000 hectares over and above the 33,000 hectares expected if irrigation stays at 0.2 percent of total spending. The impact of increasing irrigation investment is an acceleration of agricultural growth from 3 percent per year under the baseline scenario to 3.8 percent under the irrigation scenario (Table 8). Additional spending on R&E in the extension scenario accelerates agricultural growth by a further 1.5 percent per year. This comes from increasing the share of R&E expenditure from 1.2 to 4.0 percent of total spending. These two scenarios suggest that increasing the share of government spending on agriculture to 10 percent would allow agriculture to reach an average growth rate of 5.3 percent during 2006–15.

[11] We assume all land under cultivation in the lowlands and midlands is irrigable. We exclude the highlands since Kenya's agricultural research institute excludes irrigation trials in this region due its more favorable rainfall patterns.

Table 8. Growth outcomes under investment scenarios

	GDP share 2003	Average annual growth rate (%)				
		Baseline	Irrigation	Extension	Roads	Market
GDP factor cost	100.0	3.0	3.2	3.5	3.8	3.9
Agriculture	23.5	3.0	3.8	5.3	6.0	6.1
Cereals	2.9	2.5	3.1	4.2	4.6	4.6
Roots & tubers	3.1	0.9	1.7	4.4	4.8	4.6
Horticulture	3.7	4.0	4.6	10.6	11.4	11.2
Export crops	6.1	4.0	5.7	3.6	4.9	5.4
Livestock	6.6	3.0	3.0	4.4	5.0	5.1
Industry	21.2	2.8	2.6	2.5	2.4	2.7
Food processing	4.2	1.0	0.9	1.0	1.1	1.5
Private services	42.7	3.3	3.3	3.3	3.3	3.5
Public services	12.6	2.0	2.2	2.5	2.8	2.8

Source: Kenyan CGE-microsimulation model
Note: *Food crops* include all edible crops (such as cereals, roots, pulses); *cash crops* include both export and industrial crops (such as cut flowers, tea, horticulture, tobacco); *light industry* includes textiles, clothing, and wood and paper products; and *heavy industry* includes chemicals, petroleum, and machinery and equipment.

This acceleration of agricultural growth under the irrigation scenario is driven by strong growth in export crops, especially tea and sugarcane, which have better access to foreign markets and are less constrained by domestic market opportunities. However, despite market constraints, food and horticultural crops, especially rice, pulses, and fruits and vegetables, grow more strongly as a result of irrigation and improved water management.[12] By contrast, the livestock sector remains unaffected since productivity in this sector is not directly linked to irrigation, and falling feed prices offset any resource competition with other sectors. However, extension services do affect livestock productivity and so there is more rapid growth in the livestock sector under the extension scenario. By contrast, public extension services do not directly increase productivity among export crops since these crops typically rely on private-sector schemes. Therefore, public extension services cause resource competition between export and other sectors, and the improved profitability of nonexport crops and livestock cause farmers to reallocate resources away from export crops. Accordingly, growth in export crops slows from 5.7 to 3.6 percent under the extension scenario. The impact on traditional export crops is more pronounced, with production in tea and coffee slowing dramatically. This emphasizes the need to partner public service provision with private-sector initiatives, and as will be seen in subsequent scenarios, to increase rural infrastructure and market access for traditional export crops.

Faster agricultural growth resulting from additional rural investments increases household incomes, especially in rural areas where most households engage in agricultural activities and therefore incomes are directly affected. Increasing irrigation and R&E spending causes the national poverty

[12] See Table A4 in the appendix for detailed sectoral growth rates under the investment scenarios.

headcount to fall more than it does under the baseline scenario (Table 9). Poverty declines by an additional 1.8 percentage points under the irrigation scenario and by a further 3.4 percentage points under the extension scenario. The larger impact of extension services is partly due to the larger increase in investment spending under this scenario. Not surprisingly, rural poverty declines by more than urban poverty in both scenarios, and this is concentrated in the lowlands and midlands, since the highland region has better rainfall patterns and hence benefits less from irrigation investments. However, while the lowland and midland regions both benefit from irrigation, they are the regions that experience larger declines in poverty after improved R&E services. This is because these regions are already more heavily engaged in crops that benefit greatly from extension services, such as vegetables, wheat, and maize. Poverty in the lowlands does decline when incomes rise, primarily from oil crops and livestock. Finally, while irrigation improves rural incomes, it does little to reduce poverty in urban areas. However, extension services reduce food crop prices, thereby indirectly raising real incomes and lowering urban poverty by 0.7 percentage points by 2015. This is substantially less than the decline in rural poverty, which falls by 6.2 percentage points. Together, the model results suggest that increasing agricultural spending to 10 percent of total spending could lift an additional 1.6 million people above the poverty line by 2015, compared with the current growth path.[13]

Table 9. Poverty outcomes under investment scenarios

	Poverty rate 2003	Final year poverty rate in 2015 (%)				
		Baseline	Irrigation	Extension	Roads	Market
National incidence (P0)	51.3	48.1	46.3	42.9	40.9	39.5
Rural	51.9	47.8	45.7	41.6	39.3	37.6
Urban	47.6	49.5	49.3	48.8	48.7	48.4
Lowlands	61	60.0	57.1	54.7	53.8	52.3
Midlands	54.7	51.8	49.1	44.9	42.5	40.7
Highlands	41.4	34.3	34.2	30.8	28.7	27.3
Metropolitan	47.1	48.3	48.3	47.9	47.9	47.9
National depth (P1)	17.9	18.0	16.6	14.9	13.8	13.2
National severity (P2)	8.2	8.7	7.8	6.9	6.3	5.9

Source: Kenyan CGE-microsimulation model
Note: The microsimulation module is based on the 1997 WMSIII (GK, 2000) and thus initial poverty rates in the model are those for 1997. The official basic needs poverty line is set at Ksh1,239 (rural) (US$21) and Ksh2,648 (urban) (US$45) per adult per month (1997 prices).

Increasing agricultural spending to meet the 10 percent target set by the Maputo Declaration can significantly reduce poverty. However, the decline in poverty falls far short of the MDG and the acceleration of agricultural growth does not reach the 6 percent growth target set by the CAADP

[13] By 2015, Kenya will have a total population of 30.7 million people, and under the current growth path, there will be 14.7 million people below the poverty line.

initiative. As such, the next section considers the impact of increasing spending on rural infrastructure and improving market development.

Supporting Investments in Rural Roads and Market Development

Apart from direct agricultural investments like irrigation and R&E, the literature also identifies poor market access and inadequate rural infrastructure as binding constraints to agricultural growth and rural development. Accordingly, in this section we increase government spending on rural feeder roads. Roads increase agricultural productivity in the same manner as irrigation from the previous section. While building new roads improves on-farm productivity, it also enables broader market development by reducing transaction costs for rural nonagricultural sectors. Government policies to improve rural distribution and marketing systems will also improve productivity for rural traders. Therefore, apart from a road investment scenario, we also consider a second scenario that simulates the development of rural markets. This is done by increasing productivity in the trade sector and reducing transaction costs for domestic and export agricultural sectors. Unlike the previous scenarios, we assume that there is no cost associated with this aspect of market development (in other words, the cost of building roads greatly overshadows the cost of implementing market-enabling policies). Therefore, while government spending increases under the roads scenario, it remains unchanged in the market scenario (Figure 5). Under the roads scenario, we increase the share of road expenditures in government spending by 2.7 percentage points, so that agricultural and new road expenditures reach 12.8 percent of total spending by 2015.[14] We assume that all additional spending is directed toward building rural feeder roads. This is equivalent to building an additional 67,500 kilometers of feeder roads by 2015, or alternatively, increasing Kenya's road stock by two-fifths, or a third of its 2006 level. In the market scenario, we halve agricultural transaction costs and increase productivity in the rural trade sector by 3 percent per year during 2006–15.

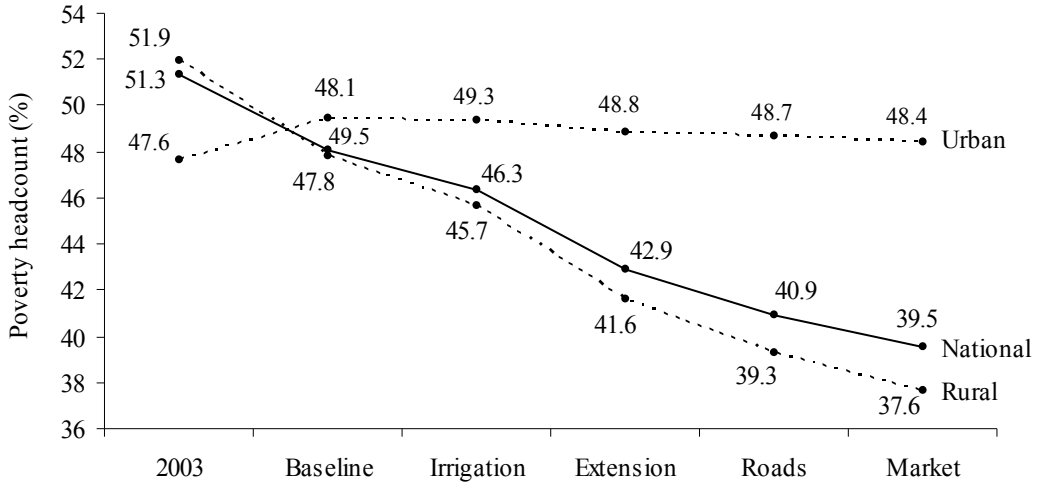
All crop and livestock sectors benefit from feeder roads. However, export and horticultural crops benefit more, since they are more heavily marketed and thus better positioned to take advantage of expanding market opportunities. Such crops include tea, cut flowers, and fruits and vegetables. By contrast, with the exception of wheat, cereal and root crops experience a slower acceleration of growth, since they are more constrained by domestic demand and by limited potential to displace imports. However, when road development is coupled with market development, as in the market scenario, then declining domestic transaction costs fosters stronger growth in cereals. This is because improvements in

[14] Increasing spending on roads obviously reduces the share of agricultural spending, which in the previous scenarios targeted 10 percent of total spending. In order to isolate the effects of road investments on growth and poverty, we do not accelerate agricultural investment alongside road investments to maintain the 10 percent agricultural share.

domestic marketing favor the food processing sectors, which in turn provide an expanding market for cereal farmers. Traditional exports also benefit from lower transport costs under the market scenario.

While it is not surprising that rural roads favors rural development, once road investments are coupled with policies to improve market access, then the benefits of investing in rural infrastructure are more broadly distributed. For example, national poverty declines by 2 percentage points under the roads scenario, but by a further 1.4 percent under the market scenario. Road and market development also reduces urban poverty, albeit only slightly (Figure 6). Road investments and market development favor poverty reduction in the midland and highland regions, which already have strong links to urban markets. However, the lowland region also benefits, since rural infrastructure is greatly lacking and transactions costs are initially high.

Figure 6. Poverty headcounts under investment scenarios, 2015



Source: Kenya CGE-microsimulation model results
Note: Outcomes are cumulative (for example, the roads scenario includes the outcomes from the irrigation and extension scenarios).

Comparing the Impacts of Different Investments

The poverty-growth and spending-growth elasticities estimated from the model results indicate that there is variation in the impact of different investments on growth and poverty (Table 10). Increasing government spending on irrigation by 1.00 percent causes a 0.06 percent increase in agricultural GDP, whereas spending an additional 1.00 percent on R&E and roads causes agricultural GDP to increase by 0.13 and 0.08 percent, respectively. However, while irrigation spending is less effective at raising growth, its resulting growth is more effective at reducing poverty. A 1.0 percent increase in irrigation-induced growth causes national poverty to decline by 3.9 percent, compared to 2.1 for R&E and 2.4 percent for roads. Irrigation investments are also considerably more effective at reducing poverty among Kenya's

poorest populations, as evidenced by its larger elasticity for the rural poverty gap and squared gap. This is because irrigation benefits the lowlands where poverty is more widespread and most severe.

Table 10. Poverty–growth elasticities and benefit–cost ratios under investment scenarios

	Baseline	Irrigation	Extension	Roads	Market
Poverty to growth	Percent change in poverty from 1 percent change in GDP				
National headcount	-0.17	-3.88	-2.09	-2.44	-1.73
Rural headcount	-0.22	-4.60	-2.34	-2.91	-2.00
Rural gap	-0.16	-5.59	-3.38	-3.83	-2.65
Rural squared-gap	-0.11	-7.57	-3.79	-4.17	-3.28
Urban headcount	0.10	-0.22	-1.02	-0.10	-0.49
Spending to growth	Percent change in GDP from 1 percent change in agricultural spending				
Agriculture	-	0.06	0.13	0.08	-
All sectors	-	0.01	0.03	0.02	-
GDP benefit–cost ratios	Ksh increase in GDP per shilling spent				
Initial elasticity	-	2.6	6.3	3.0	-
Lower bound	-	0.7	4.1	1.6	-
Upper bound	-	4.5	8.6	4.4	-
Poverty benefit–cost ratios	Poor people lifted out of poverty per Ksh million spent				
Initial elasticity	-	29	103	21	-
Lower bound	-	19	64	12	-
Upper bound	-	42	139	32	-

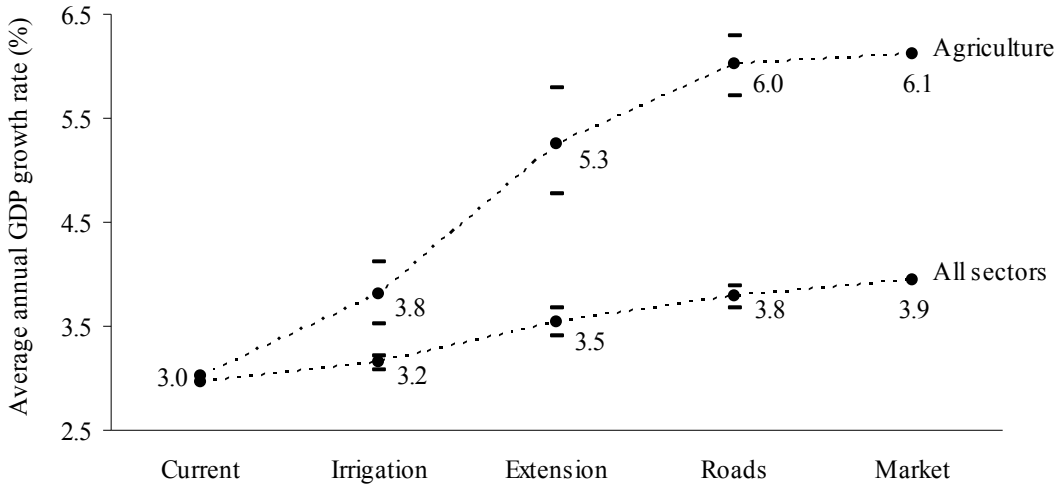
Source: Results from the Kenyan CGE-microsimulation model. Upper and lower bounds on the benefit–cost ratios assume a 25 percent confidence interval around the relevant investment function elasticity. One million shillings is equivalent to US$12,658 in 2003 prices.

We estimate benefit–cost ratios for each of the investment scenarios. These suggest that the highest returns are from direct spending on R&E. For instance, Ksh1.0 spent on R&E during 2006–15 causes GDP to increase by Ksh 6.3. By contrast, the return on irrigation and roads is 2.6 and 3.0 Kenyan shillings, respectively. Despite differing magnitudes, all investments have positive returns (that is, all benefit–cost ratios are greater than one). However, these estimated returns are sensitive to the elasticities in the productivity–investment function (equation 2). We conduct sensitivity analysis by assuming a 25 percent confidence interval around our initial estimates (Table 7). The impact of changing the elasticities can be seen in Figure 7, which shows the average annual GDP growth under each of the investment scenarios. The horizontal bars show the agricultural and economy-wide GDP growth rates that are achieved under the upper and lower bound elasticity estimates for the relevant investment. It suggests that the agricultural growth rate under the irrigation scenario varies between 3.5 and 4.1 percent, averaging 3.8 percent, assuming a 25 percent lower or higher elasticity. This sensitivity is also evident for R&E and road investments, although it is most pronounced for the former. This affects the estimated returns to investments. For instance, while there is a positive return to irrigation investment based on the initial elasticity estimate, there is a net loss under the lower bound estimate (the benefit–cost ratio is less than

one). Furthermore, the return on R&E varies from Ksh 4.1 to 8.6 per shilling spent. However, even under a lower bound estimate, the returns are higher than the initial estimates for irrigation and roads. Therefore, it suggests that, assuming a similar return to investments in Kenya as in Uganda and given a relatively wide margin of error, the returns to R&E are higher than the other investments considered.

The ranking of investments changes when their impact on poverty is considered rather than growth. While irrigation offers the lower returns to growth, it has higher returns to poverty reduction than road development. This can be explained by considering the differences in spending–growth and poverty–growth elasticities. The larger poverty–growth elasticity for irrigation offsets its smaller spending–growth elasticity. However, this is only when it is compared with road investments. Although R&E-induced growth is less effective in reducing poverty than irrigation-induced growth, R&E spending is considerably more effective at raising growth. It is this combination of "pro-poor" and "pro-growth" that makes R&E better at reducing poverty. An additional 103 people are lifted above the poverty line for every million shillings spent on R&E during 2006–15. Less than a third as many people would be lifted above the poverty line if those funds were spent on either irrigation or rural roads. However, despite the strong results for extension services, it should be remembered that irrigation spending is more effective at reducing poverty in the lowland region, where poverty is most severe, and that roads and market development generate broad-based agricultural growth and benefit urban consumers alongside rural households.

Figure 7. Average annual GDP growth under investment scenarios, 2006–15



Source: Kenya CGE-microsimulation model results
Note: Outcomes are cumulative (for example, roads include the outcomes from irrigation and extension). Horizontal bars show upper and lower bounds after assuming a 25 percent confidence interval around the relevant investment function elasticity.

5. CONCLUSIONS

Our findings indicate that Kenya must focus its development strategy on accelerating economic growth, because under its current growth path there will be little change in poverty over the coming decade. However, under its current *structure* of growth, Kenya's economy would have to grow by more than 10 percent per year over the coming decade if it is to meet the MDG of halving poverty by 2015. Given the scale of this challenge, it is clear that no single sector can lead development on its own. However, since few countries have achieved and sustained such growth, it is also clear that Kenya must search for alternative sources of *poverty-reducing* growth. Here our findings strongly indicate that agricultural growth must play a more central role in Kenya's development strategy. Without agricultural growth, it is unlikely that significant declines in poverty can be achieved, at least in the foreseeable future. The need for broad-based growth also applies to subsectors within agriculture, each of which will have to contribute to growth for Kenya's development strategy to be successful. Despite differences across agricultural sectors, agriculture generally generates growth that is more beneficial to a majority of Kenyans. This is especially true for poorer households in less-favored regions. Therefore, it is unlikely that the current strategy, which is not optimistic about agriculture's growth potential, can have a profound effect on poverty. Furthermore, an industry-led growth strategy that does not also increase investments in agriculture will exacerbate Kenya's already high inequality. Even in urban areas, the gap between formal and informal sectors means that industrial policies geared toward the formal sector are unlikely to benefit the urban poor in large numbers. Therefore, our findings conclude that, as Kenya prepares its new national strategy, the country should direct greater emphasis and resources toward accelerating agricultural growth.

We have explored how agricultural growth can be accelerated through increasing public spending on agriculture and the rural sector. We find that increasing agricultural spending to meet the 10 percent target set by the Maputo Declaration can lift an additional 1.5 million people above the poverty line by 2015. Irrigation and R&E greatly accelerate growth for both food and export crops and benefit households throughout the country. Specific investments have higher returns in different parts of the country. Irrigation investments favor the lowlands and Kenya's poorest populations, whereas R&E favors the midlands and highlands. R&E is found to have the highest returns in terms of both growth and poverty reduction. However, the reduction in poverty resulting from meeting the 10 percent agricultural spending target is only one-third of the reduction required to meet the MDG. Furthermore, increasing agricultural spending to 10 percent of total spending is insufficient to meet the CAADP agricultural growth target of 6 percent. Achieving this target will require additional nonagricultural investments, such as improved rural infrastructure and rural market development. Whereas building rural roads and reducing transaction costs

is an expensive option, we find that these investments significantly reduce rural poverty and encourage growth that extends beyond rural areas.

The total cost of increasing agricultural and rural investments to achieve the 6 percent CAADP growth target is about $127 million per year during 2006–15 in 2003 prices. The additional spending over and above the 10 percent committed to under the Maputo Declaration is $54.9 million. However, improving the efficiency of government investments could reduce these cost estimates. We have shown that even slight improvements in the relationship between investment and productivity can greatly improve growth and poverty outcomes. Therefore, while it is necessary to increase spending on agriculture, the fiscal burden of an agricultural growth strategy can be reduced through better fiscal management and implementation. Finally, we find that while the 6 percent agricultural growth target set under the CAADP initiative will cause a significant decline in poverty, it still falls far short of halving poverty by 2015. Therefore, while agricultural growth should be given a more central role in Kenya's development strategy, it will also be necessary to continue to encourage urban and nonagricultural growth. However, Kenya's development strategy will have to move beyond its current emphasis on formal industrialization if the benefits of future growth are to be shared throughout the population.

APPENDIX: SUPPLEMENTARY TABLES

Table A1. Structure of the Kenyan economy, 2003

	National economy	Urban economy		Rural economy	Agrological region			Metropolitan centers
		Informal	Formal		Lowlands	Midlands	Highlands	
	Contribution to national gross domestic product (%)							
GDP factor cost	100.0	12.0	54.7	33.2	4.7	24.9	14.1	56.3
Agriculture	100.0	5.7	6.9	87.4	5.6	60.2	32.6	1.7
Industry	100.0	12.1	68.5	19.4	2.9	11.3	9.6	76.2
Services	100.0	14.7	69.8	15.5	5.1	15.1	8.0	71.8
	Contribution to region and economy's gross domestic product (%)							
GDP factor cost	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture	23.5	11.1	3.0	61.8	27.6	56.9	54.3	0.7
Cereals	3.1	0.1	0.0	9.3	5.1	9.0	4.5	0.0
Roots and oils	3.0	0.1	0.1	8.8	3.7	9.1	3.7	0.0
Horticulture	3.6	0.2	0.0	10.8	1.8	7.4	12.1	0.0
Export crops	6.4	0.2	0.3	18.8	2.4	13.9	20.3	0.0
Livestock	6.3	10.5	1.0	13.3	12.9	15.2	12.7	0.1
Forestry and fishing	1.1	0.0	1.6	0.7	1.8	2.2	1.1	0.6
Industry	21.8	21.9	27.3	12.7	13.1	9.9	14.8	29.5
Food processing	4.1	2.1	4.6	4.1	2.6	1.9	2.3	5.7
Services	54.7	66.9	69.8	25.5	59.3	33.2	30.9	69.8
Retail trade	6.5	23.4	1.8	8.2	9.5	5.6	4.0	7.3
Public services	14.9	0.4	20.8	10.3	25.0	19.9	13.4	12.2

Source: Authors' calculations using the 2003 Kenyan social accounting matrix (Kiringai, Thurlow, and Wanjala 2006)Note: *Informal economy* comprises private businesses or activities in urban areas that are not registered to pay taxes; *Lowland*, *midland* and *highland* refer to agro-ecological regions; *metropolitan* includes cities and towns with over 100,000 residents.

Table A2. Sectors and commodities in the CGE-microsimulation model

Agriculture	Industry	Services
Cereal crops	*Food processing*	*Private services*
Maize	Meat & dairy	Trade
Wheat	Grain milling	Hotels
Rice	Sugar, bakery & confectionary	Transport
Barley	Beverages & tobacco	Communication
Other cereals	Other manufactured food	Finance
Roots and oil crops	*Light industry*	Real estate
Roots & tubers	Textile & clothing	Other services
Pulses & oil seeds	Leather & footwear	*Public services*
Horticultural crops	Wood & paper	Health
Fruits	Printing and publishing	Education
Vegetables	*Heavy industry*	Roads
Export crops	Mining	Agricultural irrigation
Cotton	Petroleum	Agricultural research and extension
Sugarcane	Chemicals	Other agriculture
Coffee	Metals and machines	Administration and other
Tea	Nonmetallic products	
Cut flowers	Other manufactures	
Others cash crops	*Other industry*	
Livestock	Water	
Beef	Electricity	
Dairy	Construction	
Poultry		
Sheep, goat, and lamb for slaughter		
Other livestock		
Other agriculture		
Fishing		
Forestry		

Table A3. Assumptions in calibrating the baseline scenario

	Annual growth rate	Source and notes
Population	1.9%	WMSIII (GK 2000) and World Bank (2006). Baseline
Rural	1.5%	assumes a slowdown in urbanization and overall population
Urban	2.4%	growth (as per observed trends).
Labor supply	2.2%	Skilled and semi-skilled growth rate based on weighted
Skilled labor	2.2%	rural/urban population growth rates. Unskilled labor supply
Semi-skilled labor	1.9%	is endogenous, based on labor demand (shown here only for
Unskilled labor	3.0%	comparison).
Land supply	1.0%	FAOSTAT (2006). Average area growth, 1990-2004
Capital depreciation rate	7.0%	Onjala (2002). Higher than Odhiambo et al. (2004) but
Capital–output ratio	2.0	produces a consistent capital stock growth rate.
Foreign capital inflows	1.0%	World Bank (2006). *Change in*
World commodity prices	-0.5%	*terms-of-trade and current account*
Government recurrent spending	1.5%	Average growth rate for 2000–04 (Table 1).
Sector growth rates	Table 2	National accounts, Government of Kenya

Table A4. Detailed growth rates under investment scenarios

	GDP share 2003	Annual GDP growth rate (%), 2006–15				
		Baseline	Irrigation	Extension	Roads	Market
Cereal crops	2.9	2.5	3.0	4.3	4.4	5.1
Maize	2.6	2.5	3.1	4.1	4.5	4.6
Wheat	0.0	1.0	1.5	9.3	9.9	7.8
Rice	0.1	3.0	4.5	5.4	5.5	5.6
Barley	0.1	0.4	0.5	1.2	1.2	1.4
Other cereals	0.0	-1.8	-0.6	4.5	5.2	7.5
Roots and oil crops	3.1	0.9	1.5	4.8	4.9	5.0
Roots & tubers	1.1	2.1	2.7	3.8	4.2	4.3
Pulses & oil seeds	2.0	0.1	1.0	4.7	5.1	4.7
Horticultural crops	3.7	4.0	4.5	11.7	12.1	12.1
Fruits	1.4	3.0	3.9	7.7	8.1	8.0
Vegetables	2.3	4.5	5.0	12.0	13.0	12.8
Export crops	6.1	4.0	5.3	2.4	3.3	3.4
Cotton	0.0	0.7	0.9	1.1	1.3	1.5
Sugarcane	0.2	3.0	3.4	3.0	3.1	2.4
Coffee	0.6	3.0	2.1	-1.6	-2.5	6.8
Tea	3.5	4.0	7.4	4.8	6.9	7.3
Cut flowers	1.1	4.5	2.7	1.1	1.7	-3.5
Others cash crops	0.8	4.0	4.3	4.3	4.4	4.2
Livestock	6.6	3.0	3.0	4.7	4.9	5.4
Beef	1.6	3.0	3.0	4.1	4.6	4.8
Dairy	2.5	3.0	3.1	4.6	5.2	5.3
Poultry	1.6	3.0	2.9	4.5	5.1	5.2
Sheep, goat & lamb	0.5	3.0	2.9	4.4	5.0	5.1
Other livestock	0.4	3.0	2.9	4.7	5.4	5.5
Food processing	4.2	1.0	0.9	1.0	0.9	2.1
Meat & dairy	1.2	1.0	0.8	1.0	1.2	1.6
Grain milling	0.9	1.0	1.2	1.4	1.7	2.0
Sugar and bakery	0.5	1.0	1.1	1.0	1.2	1.5
Beverages & tobacco	1.5	1.0	0.9	0.7	0.7	1.2
Other foods	0.1	1.0	-0.2	-0.9	-1.4	0.8

Source: Kenyan CGE–microsimulation model

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