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**G**hana has experienced persistent growth with a record of positive per capita gross domestic product (GDP) growth over the past 26 years. As a result, the country is bound to become the first Sub-Saharan African country to achieve the first Millennium Development Goal (MDG1) of halving poverty and hunger ahead of the target year 2015. Underlying this success are the country's significant efforts to build institutions and state capacity. Ghana has become a stable democratic state, as demonstrated in a peaceful transition of power in two consecutive free and fair elections in 2000 and 2008. Governance indicators have been steadily improving over the past years, and in 2007 Ghana ranked ahead of regional averages of Asia, Latin America, and Africa in most important governance indicators, including government effectiveness, regulatory quality, and control of corruption (Kaufmann, Kraay, and Mastruzzi 2009). The country is ranked among the top 10 African countries in terms of freedom of the press and academic freedom (Freedom House 2008). Financial market development has made remarkable progress over the past years, including improvements in the banking sector, increasing trade volumes in the stock exchange, and the launch of government bonds. The domestic tax base has been broadened significantly over the past years, marking an important step toward reducing dependence on cocoa for government revenues. Decentralization has improved the allocation of public resources and the provision of services to address regional disparities (Bogetic et al. 2007). Perhaps most importantly, Ghanaians are determined to reach middle-income status and catch up with successful transformation countries in Asia, such as Korea, Malaysia, and Thailand, all of which started out at lower per capita income levels in the early 1960s than Ghana.

Although the share of agriculture in total GDP has declined and the service sector has replaced the agricultural sector to become the largest component of the economy in recent years, agriculture remains the most important sector for employment. Agriculture continues to grow at a rate consistent with the overall economy, but its growth is not driven by productivity growth. Yields of most crops are still far below their potentials, and the level of modern technology adoption in agricultural production and processing is still extremely low. Agriculture remains highly dependent on rainfall: irrigation in Ghana is used on only 3 percent of total crop area, and less than 20 percent of irrigation potential is realized. In contrast, the potential for land expansion has been reaching its limits in some agroecological zones, urging a rapid shift toward productivity-led growth to transform traditional agriculture.

Against this background, the Government of Ghana has chosen to make the agricultural sector a key part of its development plan. To analyze the role of agricultural growth acceleration for Ghana's future development, the recursive dynamic computable general equilibrium (DCGE) model described in Chapter 2 is used for the analysis of growth options and poverty reduction. The remainder of the chapter is structured as follows. We first review the structure of Ghana's agricultural sector, including its recent growth performance. We then describe the structure of the Ghanaian DCGE model and its underlying data sources. The model results are presented for the baseline and accelerated growth scenarios, and then for the investment analysis. The latter is based on country-specific regression analysis. The final section draws together our findings from the Ghanaian case study and identifies policy options for realizing the potential for agricultural growth and poverty reduction.

## Agriculture in Ghana

Agriculture in Ghana accounts for more than 30 percent of GDP and three-quarters of export earnings. It employs 60 percent of the labor force. With an average annual rate of 5.5 percent, Ghana's recent agricultural growth has been more rapid than growth in its nonagricultural sectors (World Bank 2007). Moreover, in contrast to growth in the early period (Table 6.1), the main driving factor behind the recent rapid agricultural growth is the crop subsector (excluding cocoa), the largest subsector in agriculture, accounting for more than two-thirds of the agricultural economy. Staple crops, including maize, sorghum, rice, cassava, yams, plantains, pulses, and oilseeds, dominate this subsector. Some high-value crops, such as vegetables and fruits, are also included, but they play a relatively modest role in overall agricultural growth because they make up a small share of the sector.

Cocoa is Ghana's most important traditional export crop and has received special attention from the government in terms of financial and policy supports. As

**Table 6.1—Agricultural gross domestic product (GDP) growth, 1991–2006 (percent)**

Sector	1991–95	1996–2000	2001–05	2006
Annual agricultural GDP growth	2.0	3.9	5.5	5.6
Crops other than cocoa	1.5	3.4	4.5	5.8
Cocoa production and marketing	7.0	6.0	14.8	8.3
Forestry and logging	1.9	10.8	5.1	2.5
Fishing	1.8	0.6	3.0	3.6
Share of agricultural GDP				
Crops other than cocoa	69	68	68	66
Cocoa production and marketing	8	9	10	13
Forestry and logging	7	9	10	10
Fishing	15	14	12	11
Contribution to agricultural growth	100	100	100	100
Crops other than cocoa	51	60	55	69
Cocoa production and marketing	28	14	28	19
Forestry and logging	7	24	9	4
Fishing	14	2	7	7

Source: Authors' calculations using data from Bogetic et al. (2007) and GSS (2007).

a result of this attention and of favorable world prices in recent decades, the cocoa sector has grown more rapidly than the agricultural sector as a whole except during 1996–2000 (see Table 6.1). Thus, cocoa's contribution to agricultural growth is almost three times its share of the economy.

As in most African countries, agricultural growth in Ghana has been mainly driven by land expansion rather than productivity growth. Table 6.2 shows that cultivated land expanded by 60 percent over 12 years, from 4.5 million hectares in 1994 to 7.2 million hectares in 2006. Land expansion has slowed down in recent years, but continued to expand at an annual rate of 2.8 percent. The cocoa sector has been the main driver of land expansion. Cocoa area increased by 1.7 times during 1994–2006, whereas the total increase of cultivated land for other crops amounted to 40 percent in the same period.

Measured by crop GDP in constant terms, land productivity did not increase during this period. Compared with its level in 1994, total land productivity actually fell between 1997 and 2002 and has recovered only in recent years, primarily driven by the growth in cocoa (see Table 6.2).

Although structural change in crop production helps improve land productivity, the dominant factor for measuring land productivity is yield growth. In contrast to rapid land expansion, national yield levels of major foodcrops in Ghana have only improved modestly over the past 12 years (Table 6.3). When looking at the agro-ecological zone level, in several cases yields even fell in recent years from their levels

**Table 6.2—Agricultural land expansion and land productivity, 1994–2006**

Crop	Value			Growth rate (percent)		
				Total	Annual	Annual
	1994	2000	2006	(1994–2006)	(1994–99)	(2000–06)
Land productivity (cedi per hectare) <sup>a</sup>						
Other crops and cocoa	155	112	159	0.91	–4.77	5.97
Cocoa	162	87	188	1.56	–10.49	13.67
Crops other than cocoa	154	121	149	0.69	–4.97	3.62
Land allocation (thousand hectares)						
Other crops and cocoa	4,500	6,100	7,195	4.10	5.39	2.79
Cocoa	687	1,500	1,835	7.01	13.62	3.42
Crops other than cocoa	3,813	4,600	5,360	3.31	3.59	2.58

Source: Authors' calculations based on GSS (2007) and FAO (2008).

<sup>a</sup>Land productivity is calculated as gross domestic product at constant 2000 prices divided by hectares of cultivated land. The value is reported in new Ghanaian cedi (GHS).

**Table 6.3—Yields of major crops by agroecological zone, 1994–2005**

Zone	Maize		Rice		Cassava	
	1994–97	2002–05	1994–97	2002–05	1994–97	2002–05
Coast	1.32	1.69	3.64	2.16	10.46	13.02
Forest	1.45	1.48	1.79	1.99	7.37	8.25
Northern Savannah	1.21	1.16	1.94	2.22	7.07	9.26
Southern Savannah	1.53	1.44	2.09	2.24	9.01	7.54
National	1.51	1.56	1.94	2.18	11.87	12.53

Source: Authors' calculations using Ghana, MOFA (2007) and FAO (2008) (national data are from FAO 2008).

in the mid-1990s. For example, maize yield only increased in the Coast zone and was stagnant or even fell in the other three zones of the country.

These yields are much lower than the achievable yields for many crops in most zones of Ghana. According to the Ministry of Food and Agriculture, yields for most crops are 20–60 percent below their achievable levels using existing technologies combined with modern inputs, such as fertilizers and improved seeds (Table 6.4).

On the demand side, market opportunities do exist to support agricultural growth in Ghana. Like many other African countries, Ghanaian households spent 40–50 percent of their incomes on food. Food demand from the domestic market is expected to further grow with income and population growth and the process of urbanization (Diao, Dorosh, and Rahman 2007). There is also considerable potential for import substitution through increased competitiveness. Ghana imports 60 percent of rice and 90 percent of poultry meat consumed domestically. Demand

**Table 6.4—Yield gaps in Ghana, 2006**

Crop	Average yield, 1990–2006 (tons per hectare)	Achievable yields (tons per hectare)	Yield gap (tons per hectare)	Yield gap (percent)
Maize	1.5	2.5	1.0	40.0
Rice	2.1	3.5	1.4	40.0
Millet	0.8	1.5	0.7	46.7
Sorghum	1.0	1.5	0.5	33.3
Cassava	11.9	28.0	16.1	57.5
Cocoyams	6.7	8.0	1.3	16.3
Yams	12.4	20.0	7.6	38.0
Plantains	8.1	10.0	1.9	19.0
Sweet potatoes	8.5	18.0	9.5	52.8
Cowpeas	1.0	1.3	0.3	23.1
Groundnuts	0.8	1.0	0.2	20.0
Soybeans	0.8	1.0	0.2	20.0
Cocoa	0.4	1.0	0.6	60.0

Source: Authors' calculations using Ghana, MOFA (2007).

Note: According to the Ministry of Food and Agriculture's definition, achievable yields are derived from on-farm observations, where recommended technologies have been used together with more effective extension services.

for these two commodities is highly income elastic, indicating a rise in imports in the future without improvements in domestic competitiveness (see Table 6A.1 in the appendix to this chapter). Moreover, as Thailand, Malaysia, Brazil, and many other developing countries have demonstrated, rapid diversification of agricultural exports is possible and can help accelerate growth in agriculture and economic transformation in general (Breisinger et al. 2008).

This discussion indicates that the potential for a Green Revolution exists in Ghana on both the supply and demand side. Below we present the model developed used in this chapter to capture these supply–demand linkages. We then apply the model to assess the potential impacts of a Green Revolution on growth and poverty reduction in Ghana.

### The Ghanaian DCGE Model

A detailed social accounting matrix (SAM) for Ghana has been constructed based on recent data. This SAM represents the Ghanaian economy in 2007 and has 28 agricultural subsectors that are further disaggregated into the four agroecological zones as discussed above (see Table 6A.2 in the appendix to this chapter). The input side of the agricultural structure is also highly disaggregated. Not only are key intermediates (such as fertilizer and seeds) included, but the factor markets are also dis-

aggregated into agricultural family labor that is employed only in agriculture at the zonal level, unskilled labor that can move between agriculture and non-agriculture, and skilled labor employed mainly in nonagricultural sectors. Agricultural land can be allocated among different crops within each zone, but it cannot move across zones. The SAM captures remarkable differences in production structures between the Northern Savannah and the other zones of Ghana. Even though the Northern Savannah zone produces more than 34 percent of the country's cereals and about 40 percent of its livestock, this zone makes the lowest contribution to agricultural exports (only 10 percent). Cocoa is the most important export crop in Ghana, but it can only be grown in the Forest and parts of the Coast zones. The limited export opportunities for the Savannah zones' agriculture will be a challenge for these zones to benefit from any export-oriented growth strategy discussed below.

To capture the linkages of agriculture with the rest of the economy, the SAM and the model include 32 nonagricultural sectors, many of which are agricultural processing sectors, which is consistent with Ghana's current manufacturing structure. Service sectors are also highly disaggregated to capture the sector's market linkages with agriculture and nonagriculture through transportation, trade, and financial services, which are all explicitly defined in the model.

The SAM first aggregates consumers by rural and urban location, and then by the four agroecological zones. Households in the country's capital city, Accra, are separated as a stand-alone group from the rest of the urban households in the Coast zone (where Accra is located) because of their very different income level and consumption patterns. We then further classify households according to 10 deciles that are defined by per capita income levels nationwide. In total, the model has 90 representative household groups. Incomes distributed across households are endogenous variables. Although rural households earn their income from factors (land, capital, and family labor) employed in agricultural production, they also participate in non-farm activities through markets for unskilled and skilled labor that are economywide factors. Urban households earn capital income and wages for skilled labor employed in nonagricultural activities and wage income for unskilled labor employed in both agricultural and nonagricultural activities. To capture growth impact on poverty, the DCGE model is further linked with a microsimulation model, which includes all sample households in the survey dataset (see Chapter 2 in this volume).

### Baseline and Accelerated Growth Scenarios

Two scenarios are considered. The first scenario simulates a business-as-usual situation of economic development, which is called the "baseline" scenario. This scenario assumes that the Ghanaian economy will continue to grow along the recent trends until 2015. The second scenario models an accelerated growth path that is

associated with an increase in agricultural productivity. In this scenario exogenous increases in total factor productivity (TFP) at the agricultural subsector level (crops and livestock production) are the driving forces for growth to attain achievable yields nationwide by 2015. Land expansion remains at baseline levels. In most cases we report the model results at the national level as averages, yet the model simultaneously solves for zonal level results in the simulation. We take the different growth potentials among the four zones into consideration in designing the TFP growth rate, but unevenly distributed growth opportunities among farmers in each zone are not taken into account. For example, for farmers in areas with high agricultural potential, better market access conditions, and relatively high market participation rates (such as in some areas of eastern Ghana's Forest zone), maize yields are likely to be doubled once modern inputs are used. However, in some areas of northern Ghana with its long-term trend of land degradation, achieving a 30 percent increase in maize yields may be a challenge.

By contrasting model results of the agriculture-led growth scenario with those derived from the baseline, the transformative power of agriculture in Ghana can be assessed and analyzed. The use of the DCGE model allows for a detailed analysis of constraints, trade-offs, and linkage effects in the process, yet its results should be interpreted as a best-case scenario in which necessary investments in agricultural productivity are realized.

In the baseline scenario, land expansion is the main factor for agricultural growth, a situation consistent with recent growth patterns. Together with modest increases in productivity, agriculture grows at 4.2 percent annually in the simulated period (2007–15). Industry and services also grow according to their recent trends, at 5.6 percent and 5.2 percent per year, respectively.

The agriculture-led scenario targets higher crop yields that increase gradually over the simulated period. To identify yield targets, we choose a level of annual change in TFP coefficients for each individual crop across the four zones to endogenously obtain crop yields consistent with achievable yields by the end of the simulation period. These targeted yield levels are presented in Table 6.4. These targets require approximately 4.6–8.1 percent annual TFP growth for most crops. This growth in crop TFP, which combines with productivity growth in the noncrop sectors (mainly livestock), the endogenous accumulation of capital, and the reallocation of unskilled labor across different sectors in the economy, leads Ghana's agricultural sector to grow at an average annual rate of 6 percent, a growth rate consistent with the Comprehensive Africa Agriculture Development Programme (CAADP) target set by the New Partnership for Africa's Development (NEPAD). Agriculture is the largest sector in the Ghanaian economy: together with its linkage effects, accelerating agricultural growth through productivity change results in substantial growth of the national economy: 5.8 percent total GDP growth per year compared to 4.9 percent in the baseline scenario (Table 6.5).

**Table 6.5—Economic growth in baseline and agriculture-led scenarios (percent)**

Indicator	Historical data, 2001–06	Simulation results, 2006–15	
		Baseline	Agriculture-led growth
Annual GDP growth			
Agriculture	4.2 <sup>a</sup>	4.2	6.0
Industry	5.6	5.6	6.0
Services	5.2	5.2	5.5
Total		4.9	5.8
Contribution to growth			
Agriculture		31.8	39.4
Industry		31.7	28.4
Services		36.5	32.3
	Historical data, 2005	Simulation results, 2015	
Share of GDP			
Agriculture	38.7	37.6	38.1
Industry	27.9	27.9	27.5
Services	33.4	34.5	34.4

Source: The Ghanaian dynamic computable general equilibrium model results.

Notes: GDP = gross domestic product. Blank cells = not applicable.

<sup>a</sup>Agricultural GDP annual growth rate is the average for 1990–2006.

In the baseline scenario more than 65 percent of growth in national GDP and 62 percent of growth in agricultural GDP comes from factor accumulation, of which land expansion explains almost 40 percent of agricultural GDP growth (Table 6.6). By design, productivity becomes the dominant factor to explain growth in the agriculture-led growth scenario.

Moreover, productivity-led agricultural growth and its spillover effects are strongly pro-poor (Table 6.7). Model results show that the national poverty rate will fall to 13.5 percent by 2015 in the agriculture-led growth scenario, down from 16.9 percent in the baseline's 2015 level and from 28.5 percent of its 2005/06 level. Poverty decreases for both rural and urban households, underlining the benefits of agricultural growth for both consumers and producers. However, poverty remains high in the Northern Savannah zone, indicating that more targeted measures will be needed to reduce poverty in this region.

Productivity change in agriculture has been a key ingredient for initiating and supporting broader economic transformation in many countries. However, productivity change in agriculture has often required massive public investments, which

**Table 6.6—Sources of growth in baseline and agriculture-led scenarios (percent)**

Source of growth	Decomposition of total GDP growth		Decomposition of agricultural growth	
	Baseline	Agriculture-led growth	Baseline	Agriculture-led growth
Total growth	100	100	100	100
Labor	26.9	22.4	15.0	10.8
Land	12.7	8.7	39.5	27.5
Capital	26.2	22.2	7.9	5.3
Productivity	34.2	46.7	37.5	56.4

Source: The Ghanaian dynamic computable general equilibrium model results.

Note: GDP = gross domestic product.

**Table 6.7—Poverty impacts in baseline and agriculture-led scenarios (percent)**

Zone	Initial poverty rate, 2005/06	Final poverty rate, 2015	
		Baseline	Agriculture-led growth
National	28.5	16.9	13.5
Urban	10.8	7.6	5.7
Accra	10.6	7.7	5.3
Coast	5.5	2.8	2.0
Forest	6.9	4.2	2.9
Southern Savannah	21.6	15.2	12.6
Northern Savannah	31.9	25.7	22.3
Rural	39.2	23.7	19.2
Coast	24.0	8.8	5.1
Forest	27.7	12.3	7.9
Southern Savannah	36.7	12.5	9.7
Northern Savannah	68.3	55.5	49.6

Source: Ghanaian dynamic computable general equilibrium model results.

Note: The poverty rate is the proportion of the population with per capita consumption below the poverty line.

raises concerns about the cost of such a growth acceleration. The next section addresses the concern of how much additional public spending would be required to accelerate growth in the agricultural sector.

### Agricultural Investment Analysis

To answer the question of how much public agricultural spending is required to achieve productivity-led agricultural growth in Ghana, we estimate the required public spending by using the formula developed in Chapter 2 of this volume and

values of parameters estimated for Ghana (Benin et al. 2008) and for various African countries (for example, see Fan 2008; Chapter 2). We first provide an overview of recent trends in public expenditures in Ghana.

#### Recent Trends in Government Spending on the Agricultural Sector

As shown in Table 6.8, the Government of Ghana's resource allocation to the agricultural sector increased nearly fourfold between 2000 and 2007. Interestingly, the conventional line ministry responsible for the agricultural sector (Ministry of Food and Agriculture [MOFA]) accounted for only about 25 percent of the government's total spending on the sector. Over time agencies other than MOFA gained in terms of relative amounts spent for developing the sector. An agricultural sector expenditure review carried out across similar expenditure categories during 1995–97 showed MOFA as the highest spender of government funds allocated to the sector, accounting for between 48 and 57 percent of the government's total expenditures on the sector (MOFA 1999). This trend reflects deconcentration of public spending on the sector, which could lead to waste and inefficiencies that result in duplication of activities and poor coordination across the different public agencies. However, it could also lead to greater allocative efficiency of public resources if the non-MOFA agencies that are contributing to agriculture have better information than MOFA about the needs for and requirements of public services in their jurisdictions, including the capacity to respond to those needs.

A critical issue in the debate on using agriculture to drive overall economic development and reduce mass poverty is the disproportionately low government commitment to the agricultural sector relative to the total government budget or to the total output of the agricultural sector, especially in light of the agricultural sector's role in African economies (Diao et al. 2007). As shown in Table 6.9, counting only expenditures associated with MOFA (and the Ministry of Fisheries in earlier years) as the government's expenditures on the agricultural sector in Ghana indicates a low average expenditure share of 1.6 percent of total government spending or 1.1 percent of agricultural GDP. Agricultural spending through the Ghana Cocoa Board (COCOBOD), an agency specifically focusing on promoting cocoa production and exports, is much more than that spent by other agriculture-related government agencies. Once COCOBOD's and other agencies' spending is included, agricultural spending rises to 6.7 percent of total government spending or 4.8 percent of agricultural GDP on average between 2000 and 2007.

#### Required Public Spending on Agriculture to Achieve Accelerated Agricultural Growth

We analyze broad investment scenarios in which we first assume as a baseline that the economy continues to grow consistent with the DCGE model's baseline sce-

**Table 6.8—Government expenditures on agriculture, 2000–07 (2000 Ghanaian cedi million)**

Year	Expenditure on agriculture				
	Ministries of Agriculture and Fisheries <sup>a</sup>	Department of Forestry <sup>b</sup>	CSIR	COCOBOD	Presidential Special Initiatives
2000	5.16	0.94	3.80	20.51	0.00
2001	4.74	0.73	3.63	22.71	0.00
2002	5.30	0.68	4.50	18.06	0.00
2003	11.13	0.72	3.88	25.10	1.48
2004	19.96	3.93	6.36	36.84	2.92
2005	14.56	2.08	5.08	36.43	5.47
2006	28.47	5.57	24.17	53.49	5.65
2007	27.60	8.65	31.44	37.69	10.30

Source: Authors' calculations using data obtained from the Controller and Accountant General's Department; the Statistics, Research and Information Department of the Ministry of Food and Agriculture; and the offices of CSIR and COCOBOD.

Notes: Government expenditure is financed by internally generated funds and overseas development assistance (loans and grants). COCOBOD = Ghana Cocoa Board. CSIR = Council for Scientific and Industrial Research.

<sup>a</sup>Until 2005 the Ministry of Fisheries was part of the Ministry of Food and Agriculture.

<sup>b</sup>The Department of Forestry falls under the Ministry of Lands and Forestry.

**Table 6.9—Government expenditures on agriculture, 2000–07 (percent)**

Year	Share of total spending		Share of agricultural gross domestic product	
	Ministries of Agriculture and Fisheries <sup>a</sup>	Department of Forestry, CSIR, COCOBOD, and Presidential Special Initiatives	Ministries of Agriculture and Fisheries	Department of Forestry, CSIR, COCOBOD, and Presidential Special Initiatives
2000	0.8	4.7	0.5	3.3
2001	0.7	4.7	0.5	3.2
2002	0.7	3.9	0.5	2.5
2003	1.4	5.2	0.9	3.4
2004	2.0	6.9	1.4	5.0
2005	1.5	6.3	1.0	4.4
2006	2.2	9.1	1.8	7.4
2007	2.1	8.7	1.7	7.3
Average	1.6	6.7	1.1	4.8

Source: Authors' calculations using data from the Office of the Controller and Accountant General and the Statistics, Research and Information Department of the Ministry of Food and Agriculture.

Notes: Government expenditure is financed by internally generated funds and overseas development assistance (loans and grants). COCOBOD = Ghana Cocoa Board. CSIR = Council for Scientific and Industrial Research.

<sup>a</sup>Until 2005 the Ministry of Fisheries was part of the Ministry of Food and Agriculture.

nario. We further assume that total public spending in the baseline scenario continues to grow at the 2000–07 average of 11.6 percent per year and that the share of public agricultural spending of total spending is maintained at an average of 6.7 percent per year (see Table 6.10). We then analyze four investment scenarios to simulate public agricultural spending required to achieve the agricultural growth targeted in the agriculture-led growth scenario from the DCGE model. The scenarios vary according to the assumptions about the sources of agricultural growth deriving from different types of public spending in agriculture and rural areas. The first scenario (Scenario I) assumes that the agricultural growth-rate gap of 1.8 percentage points (6.0 percent in the agriculture-led growth scenario minus 4.2 percent in the baseline) is driven by raising public agricultural spending only. That is, public spending on the nonagricultural sector continues to grow as in the baseline scenario. Also, other factors (for example, interaction effects among different types of spending, crowding effects of public spending on private spending, and growth in non-spending factors that affect agricultural productivity and its effects) remain unchanged. The second scenario (Scenario II) analyzes the implications of raising the profile of agricultural development spending, assuming an equal (50:50) split with recurrent spending.

The third scenario (Scenario III) assumes that public spending on the nonagricultural sector grows by an additional 1.14 percentage points per year to close the nonagricultural sector growth-rate gap of 0.4 percentage points (that is, the target of 5.7 percent minus baseline of 5.3 percent).<sup>1</sup> This scenario further assumes that public spending on each of the nonagricultural sectors (education, health, roads, and so on) grows at the same rate to maintain their current shares in total nonagricultural spending. The fourth scenario (Scenario IV) is similar to the previous one except that it assumes that public spending on the different nonagricultural sectors grows at different rates to take advantage of those with greater estimated returns to spending. The motivation for this scenario is similar to that for Scenario II: to analyze the implication of raising the profile of public spending on rural infrastructure, which the evidence shows has a much larger positive and significant impact on agricultural productivity than do other interventions (for example, see Fan 2008). We adjust the shares to equal the marginal returns.

In each of the investment scenarios we simulate the public agricultural spending requirement under three assumptions regarding the efficiency of public spending (low, medium, and high) based on estimated elasticities from the literature. First, we constructed lower and upper limits of a 90 percent confidence interval around the point estimates. The minimum value of the lower limits and maximum value of the upper limits were chosen as the low and high efficiency elasticities, respectively. Then, the midpoint of the low and high efficiency elasticities was chosen as the medium efficiency elasticity. For the elasticities with respect to nonagricultural

public spending, we use a weighted average for education, health, and feeder roads, where the weights are the expenditure shares. See Table 6A.3 in the appendix to this chapter for details on the assumed values of key parameters used in the simulations. We use 2007 as the starting point for the simulations, which are run for the 2007–15 period. All simulated monetary values are in 2007 constant prices.

We have made simple assumptions to carry out the simulation exercise within the framework described in Chapter 2. The limitations of the formula discussed there also apply here. Against this cautionary background, we now present the simulation results: the spending requirements for the baseline and those for Scenarios I–IV. The parameter values used in public investment simulations are summarized in Table 6A.4 in the appendix to this chapter. The results from the investment analysis are shown in Table 6.10.

#### Investment Analysis Results: Baseline Scenario

In the baseline scenario (that is, maintaining the status quo), total government agricultural spending from 2007 to 2015 would be 3,837 million Ghanaian cedi (GHS), which represents about GHS426 million per year. Although the share of government agricultural spending in total government spending is maintained at 6.7 percent per year by design, the agricultural spending as a share of agricultural GDP will rise from 5.6 percent in 2007 to 9.4 percent in 2015. This is because government agricultural spending grows faster (11.6 percent per year) than agricultural GDP (4.2 percent per year).

#### Investment Analysis Results: Scenario I

Scenario I simulates agriculture expenditure requirements assuming that the source of additional agricultural GDP growth is derived from increasing public agricultural spending only. Although it is unrealistic to expect public agricultural spending to be the only source of additional growth, the requirements that follow can be interpreted as the total (public and private) maximum resources and investments needed to generate the additional growth, assuming similar across-the-board spending efficiencies. The simulation results show that this requires the annual growth rate in agricultural spending to increase from the baseline value of 11.6 to 58.9, 40.7, and 32.6 percent per year in the low, midpoint, and high efficiency spending scenarios, respectively. The total government budget in these respective spending efficiency scenarios is estimated to grow at 22.3, 16.0, and 14.1 percent per year.

With agricultural spending thus growing more rapidly than total spending, the share of agricultural spending in total expenditures will rise from the baseline value of 6.7 percent per year to annual average values of 34.1, 20.0, and 15.0 percent in the three spending efficiency scenarios, respectively. The share of agricultural spending in agricultural GDP will rise from the baseline value of 5.6 percent to 50.3, 23.6,

Table 6.10—Estimated government resources required to achieve accelerated agricultural growth in Ghana, 2007–15

Economic growth / government expenditure	Baseline	Scenario I			Scenario II			Scenario III			Scenario IV			
		Low	Midpoint	High	Low	Midpoint	High	Low	Midpoint	High	Low	Midpoint	High	
Annual growth rate (percent)														
Total GDP	5.2	5.8	5.8	5.8	5.8	5.8	5.8	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Agricultural GDP	4.2	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Nonagricultural GDP	5.6	5.6	5.6	5.6	5.6	5.6	5.6	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Total government expenditures	11.6	22.3	16.0	14.1	17.4	13.2	12.5	26.6	19.5	17.0	26.5	19.5	17.0	17.0
Agricultural sector	11.6	58.9	40.7	32.6	45.8	27.3	21.8	43.5	25.3	19.8	42.5	24.9	19.7	19.7
Nonagricultural sector	11.6	11.6	11.6	11.6	11.6	11.6	11.6	24.6	19.0	16.8	24.6	19.0	16.8	16.8
Government agricultural expenditure (2007 GHS billion)														
2007	0.3													
2015	0.6	10.8	4.1	2.5	5.4	1.8	1.3	4.7	1.6	1.1	4.5	1.6	1.1	1.1
Total, 2007–15	3.8	28.6	13.4	9.5	16.6	7.5	5.9	15.1	6.9	5.5	14.5	6.8	5.4	5.4
Annual average, 2007–15	0.4	3.2	1.5	1.1	1.8	0.8	0.7	1.7	0.8	0.6	1.6	0.8	0.6	0.6
Government agricultural expenditures (percent)														
Share of total expenditures														
2007	6.7													
2015	6.7	54.8	31.4	22.2	37.8	17.0	12.6	18.1	9.7	8.1	17.4	9.5	8.0	8.0
Annual average, 2007–15	6.7	34.7	20.0	15.0	23.7	12.3	10.0	13.8	8.6	7.5	13.4	8.4	7.5	7.5
Share of agricultural GDP														
2007	5.6													
2015	9.4	132.4	50.0	31.1	66.6	22.4	15.7	58.4	19.7	13.9	55.5	19.3	13.7	13.7
Annual average, 2007–15	7.5	50.3	23.6	16.7	29.3	13.3	10.5	26.5	12.1	9.6	25.5	12.0	9.6	9.6

Source: Authors' calculations based on the Ghanaian dynamic computable general equilibrium model results and assumptions about elasticities shown in Table 6A.3 in the appendix to this chapter.

Notes: In Scenario I only public spending on agriculture is increased. Scenario II is similar to Scenario I, but agricultural developmental expenditures grow more rapidly to reach an equal share with recurrent expenditures. In Scenario III public spending on both agriculture and nonagriculture are increased, where different types of nonagricultural spending grow at the same rate. Scenario IV is similar to Scenario III, but the different types of nonagricultural spending grow at different rates, such that their shares in total nonagricultural spending reflect their marginal returns. GDP = gross domestic product. Blank cells = not applicable.

and 16.7 percent per year. These values translate into additional (that is, in addition to the baseline values) spending on the agricultural sector by a total amount of about GHS5,632 million–24,725 million during 2007–15, or GHS704 million–3,091 million per year. The low and high end values correspond to the high and low spending efficiency scenarios, respectively. These ranges are rather large, which is due to the sensitivity of the elasticities and the wide range of the elasticities used—the high value is nearly three times as large as the low value. Nevertheless, these results mean that the political and institutional context of public spending programs in Ghana will be critical in determining the resource requirements. Going by the assumed midpoint value of the elasticity used, for example (0.086), the total agricultural budget from 2007 to 2015 required to achieve an agricultural GDP growth rate of 6 percent per year would be about GHS9,550 million (or GHS1,194 million per year).

#### Investment Analysis Results: Scenario II

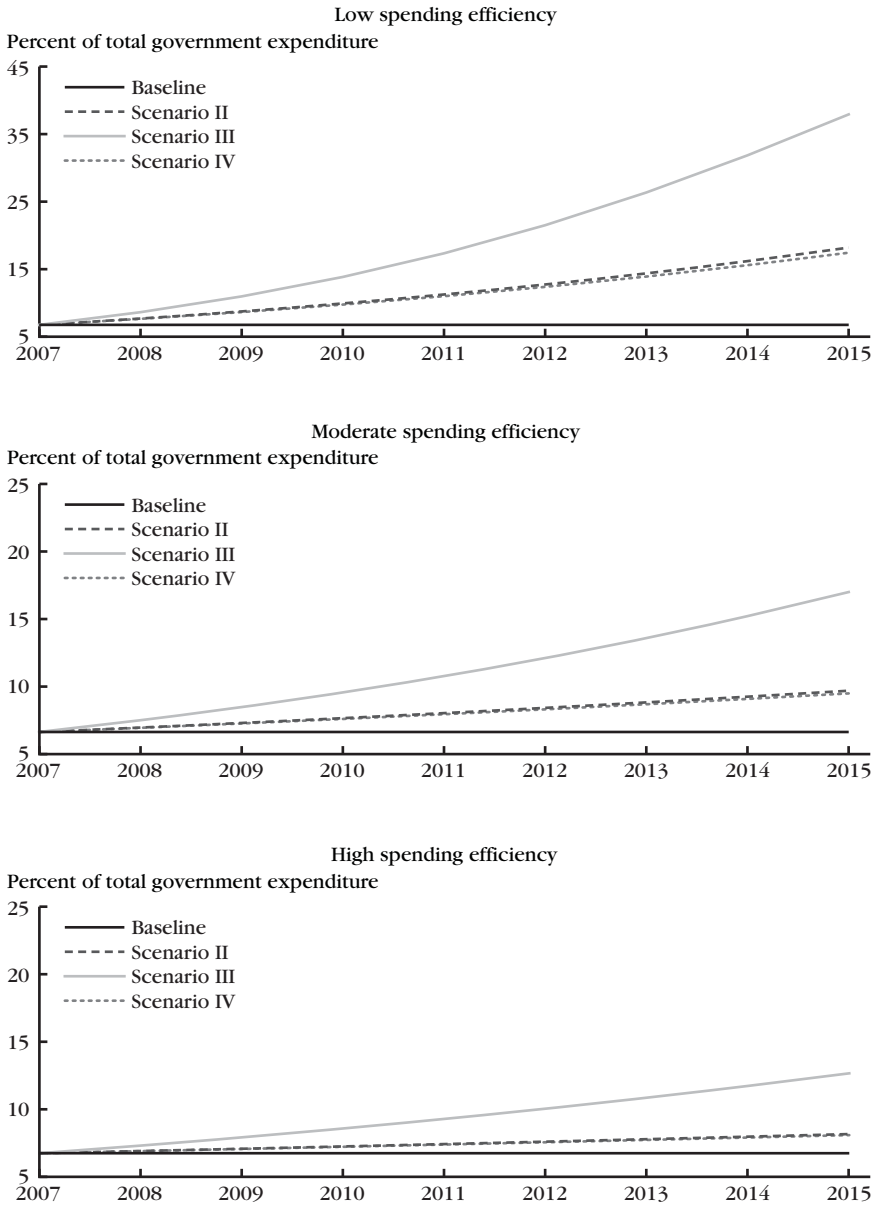
Continuing to assume that the source of additional growth is derived solely from increasing agricultural expenditures, the cost requirements are much lower when the share of development expenditure is raised to 50 percent (see Table 6.10 and Figure 6.1). The shares of agricultural spending in total expenditures are now 23.2, 12.3, and 10.0 percent in the three spending efficiency scenarios, respectively. These translate into additional spending (that is, in addition to the baseline values) on the agricultural sector by a total amount of about GHS2,100–12,790 million during 2007–15 or GHS263–1,599 million per year, less than 50 percent of the cost requirements in Scenario I.

#### Investment Analysis Results: Scenario III

In Scenario III public spending on the nonagricultural sector is also increased, but the rate of increase is the same across all nonagricultural subsectors. Because spending on the nonagricultural sector has an effect on agricultural productivity growth (with an assumed elasticity of 0.01–0.09), the simulated resource requirements for the agricultural sector are lower than in Scenario II, although the overall budgetary resources are higher.

The simulation results of Scenario III in Table 6.10 show that the average annual growth rate in public agricultural expenditure would be 43.5, 25.3, and 19.8 percent in the low, midpoint, and high efficiency spending scenarios, respectively (which is about 2–3 percentage points lower than the respective growth rates in Scenario II). The total government budget in the respective spending efficiency scenarios is now estimated to grow at 26.6, 19.5, and 17.0 percent per year. The share of agriculture in total expenditure will be 13.8, 8.6, and 7.5 percent in the three spending efficiency scenarios, respectively, while the share of agricultural spending in agricultural GDP will be 26.5, 12.1, and 9.6 percent per year. These

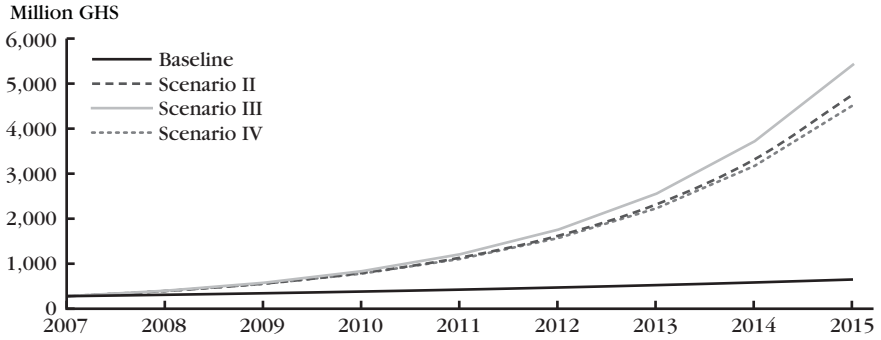
**Figure 6.1—Agricultural spending requirements in scenarios with different spending efficiencies and alternative sources of growth, 2007–15**



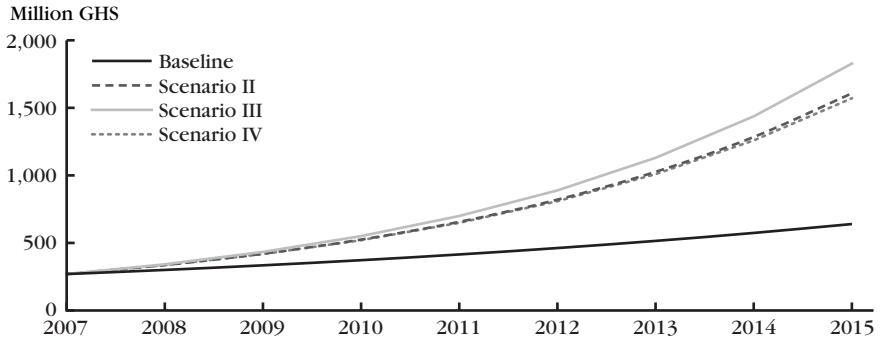
Source: Authors' calculations based on the Ghanaian dynamic computable general equilibrium model results and growth elasticities with respect to public spending.

Notes: Results for Scenario I are not plotted, as they are unrealistically high. GHS = Ghanaian cedi.

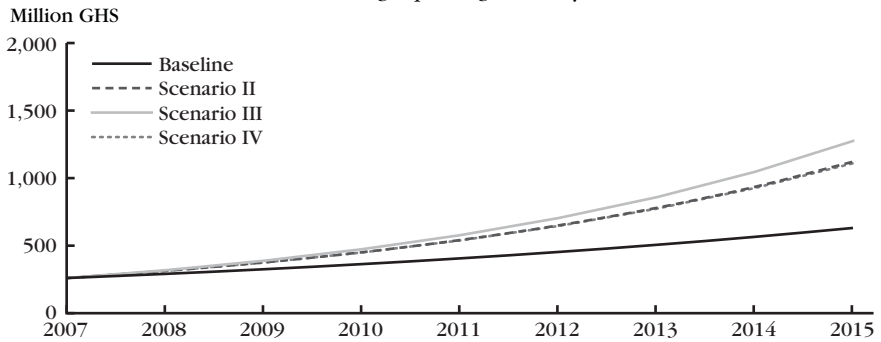
## Low spending efficiency



## Moderate spending efficiency



## High spending efficiency



numbers translate into additional (that is, over the baseline values) spending on the agricultural sector by a total amount of about GHS1,627–1,216 million over 2007–15, or GHS203–1,402 million per year. Again, the low- and high-end values correspond to the high and low spending efficiency scenarios, respectively. Comparing the resource requirements in Scenarios II and III shows little difference, reflecting the small effect of overall growth in public nonagricultural spending on agricultural growth. The literature shows that the effect of public nonagricultural spending on agricultural productivity is mainly from spending on rural infrastructure, particularly on rural roads. However, the share of government spending on rural infrastructure in general and rural roads in particular in Ghana is very small. Therefore, increasing spending on different types of nonagricultural public goods and services at equal rates is not likely to be prudent.

#### Investment Analysis Results: Scenario IV

The idea of shifting or increasing resources in favor of sectors, subsectors, or activities that contribute most to a development objective is the motivation for Scenario IV. In contrast to the previous scenario, Scenario IV has different rates of increase of public nonagricultural spending for the different sectors, so that their share in total nonagricultural spending reflects their marginal returns. The simulation results show that the average annual growth rate in public agricultural spending would be 42.5, 24.9, and 19.7 percent in the low, midpoint, and high efficiency spending scenarios, respectively (which is about 0.9, 0.4, and 0.1 percentage points lower than the respective growth rates in Scenario III). The total government budget in the respective spending efficiency scenarios grows at a lower rate (about 0.5 percent lower than in Scenario III) and now is estimated to grow at 26.5, 19.5, and 17.0 percent per year.

The share of agricultural spending in total expenditures will now be 13.4, 8.4, and 7.5 percent in the three spending efficiency scenarios, respectively, and the share of agricultural spending in agricultural GDP will be 25.5, 12.0, and 9.6 percent per year. Using the midpoint values of the elasticities, the total spending on the agricultural sector from 2007 to 2015 required to achieve the accelerated agricultural growth would be about GHS2,958 million (or GHS370 million per year), which is about 4 percent lower than the estimated requirements in Scenario III. Therefore, shifting or increasing public resources in favor of sectors, subsectors, or activities that contribute most to raising agricultural productivity growth and overall growth will be important.

#### Implications of Our Assumptions for Simulated Expenditure Requirements

Given that agricultural production in Ghana is considered a private sector activity, a key policy issue is how much the private sector should contribute toward the

resource gap. Although providing actual numbers on private sector investments is outside the scope of this research, here we discuss the implications of changing some of the underlying assumptions made in simulating the expenditure requirements. We focus on implications of policies and public spending decisions on the simulated expenditure requirements vis-à-vis their effects on private sector investments. We also discuss other effects, including improving use and efficiency of agricultural inputs and interactions among different types of public expenditures.

Regarding the public–private spending interface (that is, the idea that public plus private spending is arguably a zero-sum game in the sense that government spending is financed by taxation of private investment), external sources of funding (both loans and grants) make up about 35 percent of the Government of Ghana’s total budget expenditure (Quartey 2005). Thus, the zero-sum game argument is very important for Ghana, and how the crowding-out or crowding-in effects operate in the future will be critical for determining the total resources required to achieve the agricultural growth targets, as well as for the necessary contribution by the private sector. Thus, policies and public spending decisions that encourage private investment in farm capital will be very important. Similarly, policies and public spending that help improve use and efficiency of agricultural inputs will also be critical for raising overall agricultural productivity, reducing total resource requirements and both public and private contributions.

Interactions (complementarity or substitution effects) among different types of public spending also matter for the cost calculations. The interaction effects between agricultural expenditures and each of the nonagricultural sectors (education, health, and rural roads) were implicitly taken into account in the simulations and were incorporated into the assumed elasticities. Ministries, departments, and agencies of the different sectors may view others as competitors for national budget expenditures (another zero-sum game), which should not be the case to the extent that spending on one sector affects the performance of other sectors. Thus, policies that promote cross-sectoral programs leading to joint outcomes that are more than the sum of individual outcomes will also be important for raising overall agricultural productivity.

## Conclusions

Impressive growth and poverty reduction over the past 20 years have made Ghana an African success story. Agricultural growth has played an important role in this effort. However, agricultural growth in Ghana has been mainly driven by area expansion as opposed to a Green Revolution of the sort experienced by many Asian countries, in which growth is driven by productivity. Potential for such productivity-led growth exists in Ghana, exemplified by significant gaps between current and

achievable yields for many crops. To understand the importance and impacts of a change from the current growth pattern based on land expansion to productivity-led growth, we applied the DCGE model described in Chapter 2 to Ghana. The model disaggregates agricultural production to the agroecological zonal level, and a macro-to-microsimulation model includes all sample households of the most recent national household survey to assess the potential growth and poverty impacts of accelerated agricultural growth through productivity change.

By closing the existing yield gaps and achieving comparable productivity growth in the livestock sector, Ghana will be able to reach 6 percent average annual agricultural growth, a growth rate consistent with the CAADP goal set by African policymakers. Agricultural productivity growth benefits the whole economy through strong linkages between the agricultural sectors and the rest of the economy. In this process, incomes of both rural and urban households increase, and the resulting additional demand for agricultural products can be met by domestic supply without significantly lowering their prices. Such growth is also pro-poor. At the national level, the scenario shows that the national poverty rate will fall to 12.5 percent by 2015, lifting an additional 850,000 people out of poverty compared to the baseline scenario. However, poverty levels in northern Ghana remain high, indicating the need for additional measures beyond growth strategy.

Achieving productivity-led agricultural growth requires a significant increase in public investments in agriculture, rural infrastructure, and marketing. If the funds to support 6 percent agricultural growth come only from increasing agricultural public investment, the agricultural expenditures would have to grow by about 32–59 percent annually in the next 5–8 years, which causes the share of agriculture in total government expenditures to rise to 15–34 percent, doubling or trebling its average share during 2000–07. This amount is unrealistically large, and it is unlikely that the government would bear such costs alone. If the government is able to achieve greater efficiency in its public spending programs—for example, by shifting or increasing resources in favor of more productive sectors, subsectors, or activities (such as agricultural or rural roads development), then the resources required to achieve its development objective could be slashed by more than 50 percent. For Ghana to achieve a middle-income status led by accelerated agricultural productivity growth by 2015, it will be necessary to raise public agricultural expenditures as well as public spending on rural infrastructure, particularly feeder roads. However, it will be equally important to improve the political and institutional context of public spending programs by, for example, reforming the way public investment programs are implemented to crowd-in greater private investments and reduce crowding-out effects. Improving the use and efficiency of agricultural inputs will also be critical, as will be promoting cross-sectoral public investment programs that have large complementary effects.

## Appendix

**Table 6A.1—Household budget shares and income elasticities**

Category	Current budget share (percent)		Marginal budget (percent)		Income elasticity	
	Urban	Rural	Urban	Rural	Urban	Rural
Foods	43.5	52.0	34.6	49.0	0.8	0.9
Maize	0.8	1.8	0.4	1.2	0.4	0.7
Rice and wheat	3.7	4.3	2.6	4.4	0.7	1.0
Roots	3.0	2.6	2.2	3.3	0.7	1.3
Other foodcrops	7.2	8.6	5.2	7.3	0.7	0.8
Plantains	1.2	1.1	0.9	1.3	0.8	1.3
Chickens	1.6	1.1	2.0	1.5	1.2	1.3
Other livestock	10.8	15.6	8.5	14.4	0.8	0.9
Fish	1.9	2.1	1.8	2.3	1.0	1.1
Other foods	13.3	14.7	10.9	13.2	0.8	0.9
Nonfoods	46.1	37.0	56.6	40.0	1.2	1.1
Clothing	10.4	11.0	8.9	11.0	0.9	1.0
Other manufactures	7.0	9.6	6.9	9.7	1.0	1.0
Fuels	3.8	5.1	8.0	3.5	2.1	0.7
Durable equipment	9.4	4.8	20.9	7.6	2.2	1.6
Water and electricity	0.5	0.1	0.7	0.2	1.4	2.1
Services	25.4	17.4	20.0	19.0	0.8	1.1

Source: Estimates by Bingxin Yu, International Food Policy Research Institute, using the 2005/06 Ghana Living Standards Survey (GSS 2007).

**Table 6A.2—Structure of the Ghanaian social accounting matrix**

Agricultural sectors	Maize; rice; sorghum and millet; other cereals; cassava; yams; cocoyams; cowpeas; soybeans; groundnuts; fruits (domestic); vegetables (domestic); plantains; other crops; palm oil; other nuts; fruits (export); vegetables (export); cocoa beans; industrial crops; broiler chickens; eggs and layers; beef; sheep and goat meat; other meats; forestry; fishery
Industrial sectors	Mining; formal food processing; informal food processing; cocoa processing; dairy products; meat and fish processing; textiles; clothing; leather and footwear; wood products; paper, publishing, and printing; crude and other oils; petroleum; diesel; other fuels; fertilizer; chemicals; metal products; machinery and equipment; construction; water; electricity
Service sectors	Trade services; export services; transport services; communication; banking and business; real estate; community, other services; public administration; education; health
Factors	Agricultural family labor; unskilled labor; skilled labor; agricultural land; physical capital
Households	Disaggregated by rural/urban; four regions and Accra; and per capita expenditure deciles
Regions	Coast; Forest; Northern Savannah; Southern Savannah <sup>a</sup>

Source: Authors.

<sup>a</sup>Regions are for disaggregating agricultural sectors only.

**Table 6A.3—Growth elasticities with respect to public spending used in simulations**

Elasticity	Low value	Midpoint value	High value
Agricultural GDP with respect to agricultural spending (Scenario I)	0.053	0.086	0.119
Agricultural GDP with respect to agricultural spending (Scenarios II–IV)	0.073	0.159	0.245
Nonagricultural GDP with respect to nonagricultural spending (Scenarios II–IV)	0.200	0.350	0.500
Agricultural GDP with respect to nonagricultural spending (Scenario III) <sup>a,b</sup>	0.013	0.044	0.091
Agricultural GDP with respect to nonagricultural spending (Scenario IV) <sup>a,c</sup>	0.018	0.051	0.098
Education	0.067	0.110	0.154
Health	0.000	0.009	0.018
Feeder roads	0.094	0.106	0.119

Source: Authors' assumptions based on Fan, Zhang, and Rao (2004); Benin et al. (2008); Fan (2008).

Note: GDP = gross domestic product.

<sup>a</sup>Weighted averages based on the elasticities associated with education, health, and feeder roads, where weights are shares of spending on the three sectors in the total spending on them.

<sup>b</sup>Shares of education, health, and feeder roads are 72, 23, and 5 percent, respectively.

<sup>c</sup>Shares of education, health, and feeder roads are 53, 6, and 41 percent, respectively.

**Table 6A.4—Values of parameters used in public investment simulations**

Quantity and growth rate	Baseline value
Annual average agricultural GDP growth rate target, $\hat{\theta}_{ag}$	6.0
GDP in base period (2007 GHS million)	
Agriculture, $Q_{ag}$	4,762.2
Nonagriculture, $Q_{nag}$	8,553.9
Annual average growth rate in GDP in base scenario (percent)	
Agriculture, $\hat{Q}_{ag}$	4.2
Nonagriculture, $\hat{Q}_{nag}$	5.6
Amount expenditures in base year (constant prices 2007 GHS million)	
Public agricultural expenditure, $E_{ag}$	264.5
Public nonagricultural expenditure, $E_{nag}$	3,699.8
Annual average growth rate in expenditures in base scenario (percent)	
Agriculture, $\hat{E}_{ag}$	11.6
Nonagriculture, $\hat{E}_{nag}$ (Scenarios I–II)	11.6
Nonagriculture, $E_{nag}$ (Scenarios III–IV)	12.74

(continued)

Table 6A.4—Continued

Elasticities	Low value	Midpoint value	High value
Agricultural GDP with respect to public agricultural expenditure, $\epsilon_{E_{ag}}^Q$ (Scenario I)	0.053	0.086	0.119
Agricultural GDP with respect to public agricultural expenditure, $\epsilon_{E_{ag}}^Q$ (Scenarios II–IV)	0.073	0.159	0.245
Agricultural GDP with respect to public nonagricultural expenditure, $\epsilon_{E_{nag}}^Q$ (Scenario II) <sup>a,b</sup>	0.013	0.044	0.091
Agricultural GDP with respect to public nonagricultural expenditure, $\epsilon_{E_{nag}}^Q$ (Scenario IV) <sup>a,c</sup>	0.018	0.051	0.098
Agricultural GDP with respect to the interaction of public agricultural and nonagricultural expenditure, $\Phi_{ag,nag}^Q$	0.000	0.000	0.000
Nonagricultural GDP with respect to public nonagricultural expenditure (Scenarios II–IV)	0.200	0.350	0.500

Source: The Ghanaian dynamic computable general equilibrium model.

Note: GDP = gross domestic product. Blank cells = not applicable.

## Note

1. We assume that the elasticity of nonagricultural GDP to public nonagricultural spending is 0.35 and conduct a sensitivity analysis around this value (see Table 6A.3 in the appendix to this chapter).

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