Chapter 6

GHANA

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Including inland water bodies, Ghana covers 238,539 square kilometers and is located on the south central coast of West Africa. The country shares borders in the east with Togo, in the north with Burkina Faso, and in the west with Côte d'Ivoire. The topography of Ghana is mainly undulating, with most slopes less than 5 percent and many not exceeding 1 percent. The topography of the high rainforest is, however, mainly strongly rolling. The uplifted edges of the Voltarian basin give rise to narrow plateaus between 300 and 600 meters in elevation (Boateng 1998). Moving from the rainforest zone in the south to the Sahara Desert in the north, rainfall generally decreases and temperature increases. Rainfall is the most important climatic factor influencing vegetation in Ghana. The wettest area is in the extreme southwest, where the rainfall is over 2,000 millimeters per year. In the extreme north, the annual rainfall is less than 1,100 millimeters. The driest area is at the southeastern coastal tip, where the rainfall is about 750 millimeters. Much of the rain falls in intense storms of short duration, especially at the beginning of the season, resulting in heavy runoff and erosion. The annual mean relative humidity is about 80 percent in the south and 44 percent in the north (Dickson and Benneh 1988). The mean monthly temperature for the entire country is 25°C. Although temperatures are uniformly moderate, there are important variations over different parts of the country, reflecting altitude and distance from the sea.

The agricultural sector in Ghana includes crops, livestock, and fisheries, all contributing to national food security. Ghanaian agriculture is rainfed, with only 4 percent of its irrigation potential developed (Ghana, MOFA 2009). As the backbone of the national economy, agriculture provides employment to over 50 percent of the country's workforce and supplies over 70 percent of the national food requirements. The potential impacts of global climate change (such as unpredictable rainfall, increasing temperatures, and longer dry periods) add to the vulnerability of Ghanaian agricultural production systems. Although the general consequences of climate change are becoming better known, great uncertainty remains about how climate change will affect specific locations.

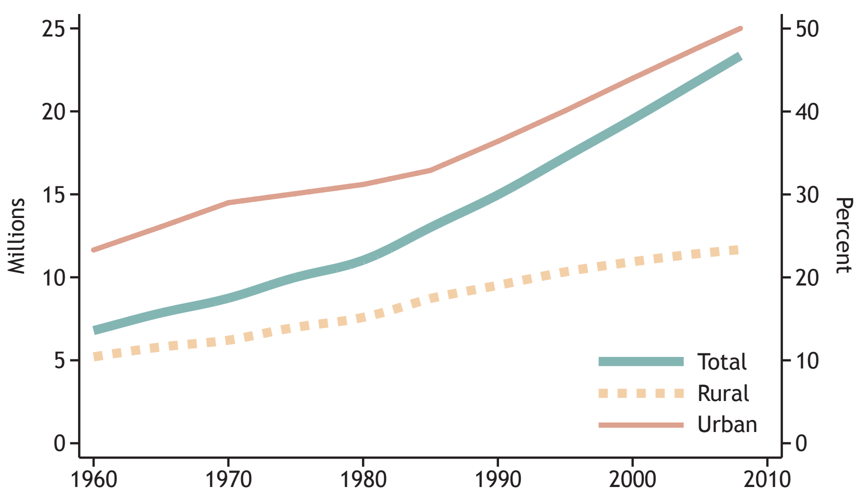
Review of the Current Situation

Population

Figure 6.1 shows trends in the total population and rural population of Ghana (left axis), as well as the shares of the rural and urban populations (right axis), and Table 6.1 shows the population growth rates between 1960 and 2008. The urban population of Ghana has been growing faster than the rural population since the country's independence in 1957, and it is now about half of the total population. The rural population has also grown steadily, peaking at 2.4 percent growth in 1990. The urban population growth rate, by contrast, although higher than that of rural areas over the entire period, fell from 4.7 percent between 1960 and 1969 to 3.8 percent between 2000 and 2008.

Figure 6.2 shows the geographic distribution of the population in Ghana. The rising urban growth rate is reflected in the population increases in several towns in the southern sector of the country—Accra, Tema, and Kumasi—with population densities greater than 2,000 persons per square kilometer. Tamale is also becoming an important growth center in the northern part of the country. Increases in the urban population are also spilling over into

FIGURE 6.1 Population trends in Ghana: Total population, rural population, and percent urban, 1960–2008



Source: World Development Indicators (World Bank 2009).

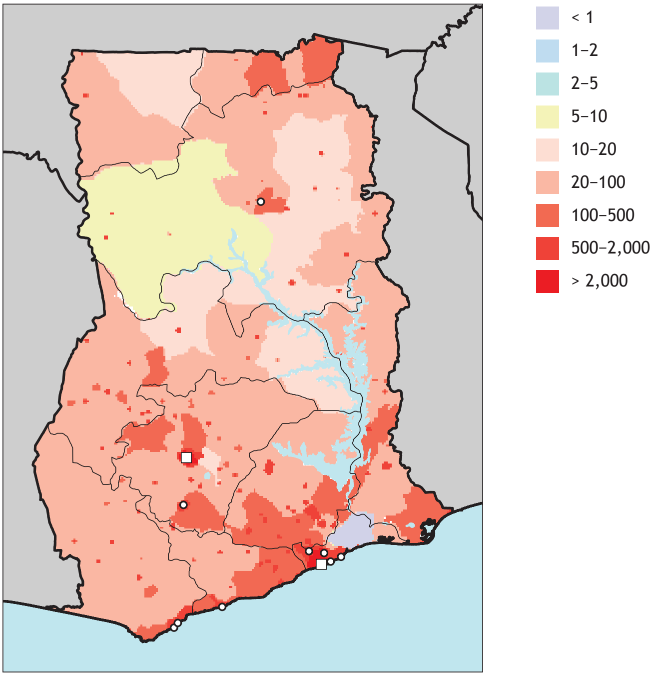
TABLE 6.1 Population growth rates in Côte d'Ivoire, 1960–2008 (percent)

Decade	Total growth rate	Rural growth rate	Urban growth rate
1960–69	2.5	1.8	4.7
1970–79	2.3	2.0	3.1
1980–89	3.1	2.4	4.6
1990–99	2.7	1.4	4.6
2000–2008	2.2	0.8	3.8

Source: Authors' calculations based on World Development Indicators (World Bank 2009).

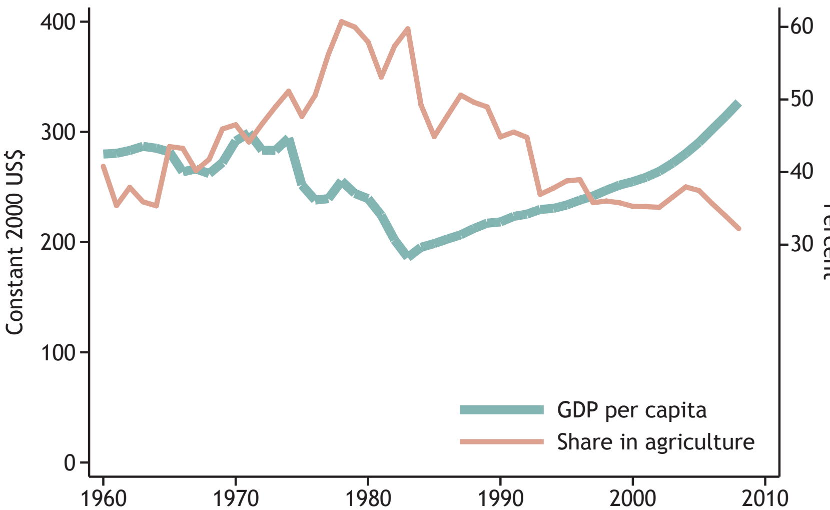
adjacent periurban areas, with population densities of 100–500 per square kilometer. Although the slowing growth rate in rural populations and the relatively smaller increase in the total rural population compared to urban areas may potentially reduce the agricultural workforce, there may be a compensating expansion in periurban agriculture to meet the food demands of urban populations, especially for vegetables.

FIGURE 6.2 Population distribution in Ghana, 2000 (persons per square kilometer)



Source: CIESIN et al. (2004).

FIGURE 6.3 Per capita GDP in Ghana, 1960–2008 (constant 2000 US$) and share of GDP from agriculture (percent)



Source: World Development Indicators (World Bank 2009).
Notes: GDP = gross domestic product; US$ = US dollars.

Income

The share of income earned in agriculture shows the importance of agriculture as a sector of the economy in Ghana. Figure 6.3 shows trends in gross domestic product (GDP) per capita and in the proportion of GDP from agriculture. The agricultural sector's contribution to GDP increased from 1960 until the late 1970s, when the sector was the largest single contributor to GDP. After the mid-1980s, however, agricultural GDP declined to less than 50 percent of the country's total GDP. Agricultural GDP has continued to decline, while per capita GDP has increased. The rapid increases in per capita GDP after 2000 may reflect the development of the service sector, especially the rapid growth in the telecommunications subsector (Ghana, GSS 2010).

Vulnerability to Climate Change

Table 6.2 provides some data on Ghana's performance on indicators of a population's vulnerability or resilience to economic shocks beyond that of income level: level of education, literacy, and concentration of labor in poorer or less dynamic sectors. The table indicates that there is nearly universal enrollment in primary

TABLE 6.2 Education and labor statistics for Ghana, 1990s and 2000s

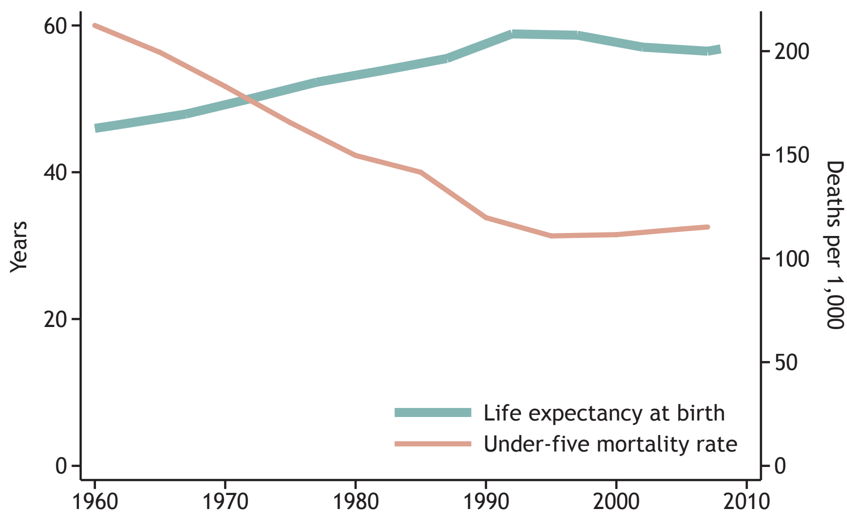
Indicator	Year	Percent
Primary school enrollment (percent gross, three-year average)	2008	103.7
Secondary school enrollment (percent gross, three-year average)	2008	53.3
Adult literacy rate	2007	65.0
Percent employed in agriculture	1999	55.0
Under-five malnutrition (weight for age)	2008	13.9

Source: Authors' calculations based on World Development Indicators (World Bank 2009).

school (three-year average) and that more than 50 percent of children gained access to secondary education in 2008. These improvements in access to formal education are reflected in the adult literacy rate of 65 percent in 2007. Literacy has the potential of reducing the population's vulnerability to economic shocks through improved access to income sources other than agriculture.

Figure 6.4 shows data for Ghana on two noneconomic correlates of poverty: life expectancy and under-five mortality. The correlates are widely used as indicators of well-being. Life expectancy rose from 45 years in 1960 to almost 60 years in 1990 but declined to 57 years in 2009. Under-five mortality

FIGURE 6.4 Well-being indicators in Ghana, 1960–2008



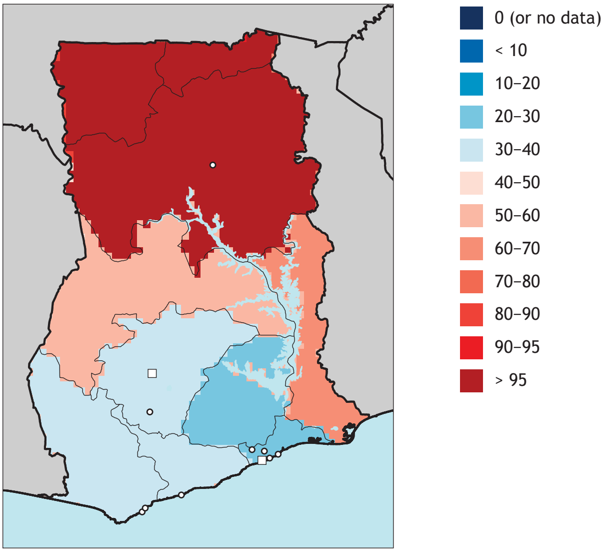
Source: World Development Indicators (World Bank 2009).

decreased from 200 deaths per 1,000 births in 1960 to 120 deaths per 1,000 births in 2008–09.

Figure 6.5 shows the proportion of the Ghanaian population living on less than US$2 (US dollars) per day. Poverty is endemic in the three northern regions, where more than 95 percent of the population is living on less than US$2 per day. Poverty generally decreases from the north to the south. Poverty rates in the Volta and Brong Ahafo Regions—areas with mostly transition vegetation—are higher than for the other southern regions but lower than for the three northern regions.

Poverty is relatively more widespread in the northern part of the country compared to the western part. There are more urban settlements and more economic activities in the west than in the north. Moreover, rainfall is greater in the west, supporting the production of tree crops. The forest sector regions of Ashanti, Central, and Western Regions share a poverty bracket. The Eastern and Greater Accra Regions have the lowest percentage of the population living on less than US$2 a day. The socioeconomic activities associated with the capital city in the Greater Accra Region and with the area around Lake Volta in the Eastern Region could account for the relatively lower poverty rate in those two regions.

FIGURE 6.5 Poverty in Ghana, circa 2005 (percent below US$2 per day)



Source: Wood et al. (2010).

Note: Based on 2005 US$ (US dollars) and on purchasing power parity value.

Review of Land Use and Agriculture

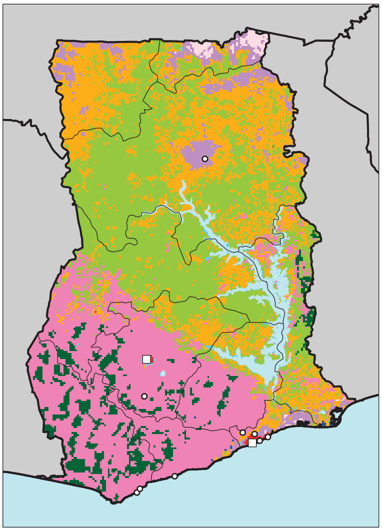
Land Use Overview

Figure 6.6 shows Ghana's land cover and land use as of 2000. The country had lost most of its evergreen forest cover by 2000, except for limited areas of the Western, Ashanti, Brong Ahafo, and Eastern Regions, as well as parts of the Akwapim (Togo ranges along Ghana's eastern borders in the Volta Region). The rate of loss of forest cover is estimated at 1.9 percent per year (Ghana, Forestry Commission 2010). The former forested areas of Western, Ashanti, Central, Brong Ahafo, and Eastern Regions now have mixtures of croplands, trees, and other vegetation types (mosaic terrain). Currently the most extensive vegetation type is open broadleaved deciduous tree cover. The northeastern area of the Upper East Region is the only part of the country that has no vegetative cover and is classified as cultivated and managed area (under permanent cultivation). The cities of Accra-Tema, Sekondi-Takoradi, Obuasi, Kumasi, and Tamale are mapped as artificial surfaces and related areas—an indication that the land covers in those areas have been significantly modified from the original natural cover. The water bodies identified and represented on the map are the Volta Lake system and Lake Bosomtwi; the other known river systems, such as Pra and Ankobrah, are not shown.

Figure 6.7 shows the locations of protected areas, including parks and reserves. Although a substantial number of areas are shown as protected areas, only a few have been classified by the International Union for the Conservation of Nature. The classified areas are in various categories and regions: one is classified as a strict nature reserve (in the Ashanti Region), five as national parks (one each in the Western, Central, Brong Ahafo, Eastern, and Northern Regions), two as habitat or species management areas (in the Ashanti and Brong Ahafo Regions), and two as managed resource protected areas (in the Western and Upper West regions).

Figure 6.8 shows travel times to towns and cities of various sizes as potential markets for agricultural products. The road network is directly related to the population distribution in the country. The best road networks are between the major cities in the southern zone—Accra, Cape Coast, Takoradi, Kumasi, and Sunyani. There are also first-class roads linking the major cities across the country along two main routes: Accra–Kumasi–Wenchi–Wa and Accra–Kumasi–Techiman–Tamale. Well-maintained road networks link most of the district capitals to the major urban towns in the various regions, providing easy delivery of goods and services. Travel times increase for communities

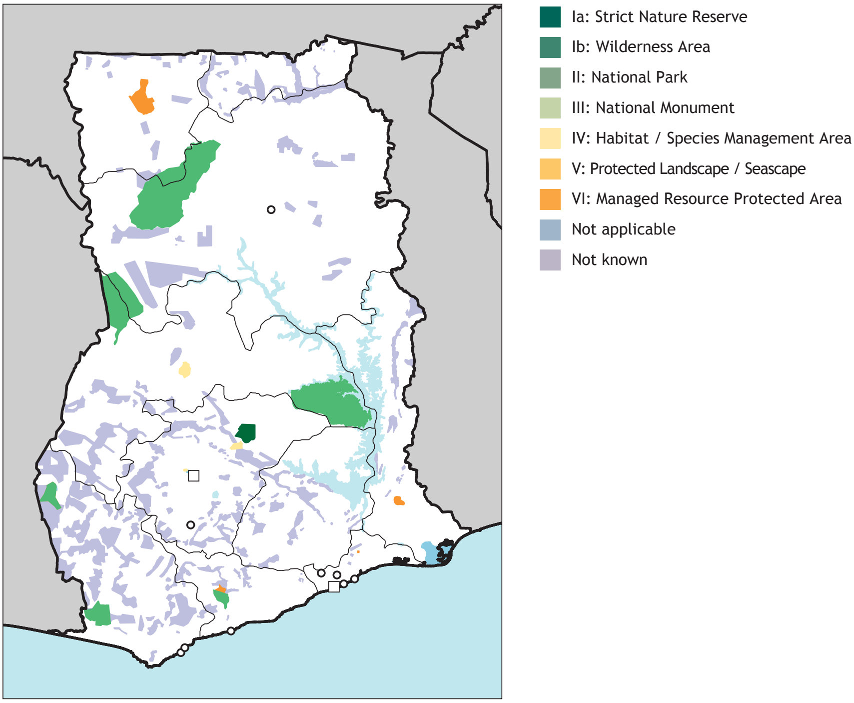
FIGURE 6.6 Land cover and land use in Ghana, 2000



- Tree cover, broadleaved, evergreen
- Tree cover, broadleaved, deciduous, closed
- Tree cover, broadleaved, deciduous, open
- Tree cover, broadleaved, needle-leaved, evergreen
- Tree cover, broadleaved, needle-leaved, deciduous
- Tree cover, broadleaved, mixed leaf type
- Tree cover, broadleaved, regularly flooded, fresh water
- Tree cover, broadleaved, regularly flooded, saline water
- Mosaic of tree cover/other natural vegetation
- Tree cover, burnt
- Shrub cover, closed-open, evergreen
- Shrub cover, closed-open, deciduous
- Herbacious cover, closed-open
- Sparse herbacious or sparse shrub cover
- Regularly flooded shrub or herbacious cover
- Cultivated and managed areas
- Mosaic of cropland/tree cover/other natural vegetation
- Mosaic of cropland/shrub/grass cover
- Bare areas
- Water bodies
- Snow and ice
- Artificial surfaces and associated areas
- No data

Source: GLC2000 (Global Land Cover 2000) (Bartholome and Belward 2005).

FIGURE 6.7 Protected areas in Ghana, 2009



Sources: Protected areas are from the World Database on Protected Areas (UNEP and IUCN 2009). Water bodies are from the World Wildlife Fund's Global Lakes and Wetlands Database (Lehner and Döll 2004).

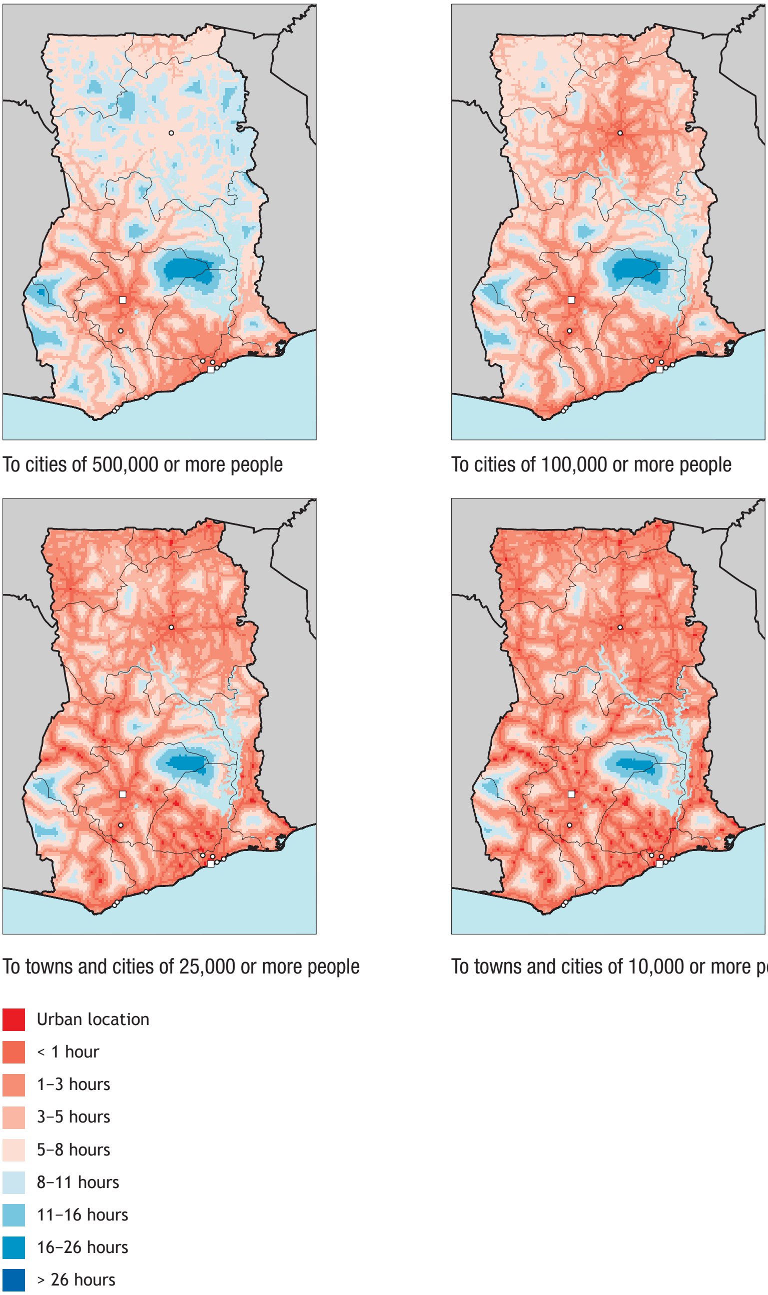
farther from established road networks, without good linking roads. For communities located beyond large water bodies, such as Lake Volta, there are additional travel challenges, because Ghana lacks a well-developed water transport system.

Agriculture Overview

The next three tables show key agricultural commodities in terms of area harvested (Table 6.3), the value of the harvest (Table 6.4), and the provision of food for people (ranked by weight) (Table 6.5). Cocoa remains the single most important cash crop in Ghana, followed by two important food security crops: cassava and maize. The two most important (food and income) crops in the northern sector are groundnuts and sorghum, which rank fourth and fifth in the country, respectively.

Yams and plantains are very important crops in terms of value of production. Although the harvested areas of these crops were lower than for other

FIGURE 6.8 Travel time to urban areas of various sizes in Ghana, circa 2000



To cities of 500,000 or more people

To cities of 100,000 or more people

To towns and cities of 25,000 or more people

To towns and cities of 10,000 or more people

Source: Authors' calculations.

TABLE 6.3 Harvest area of leading agricultural commodities in Ghana, 2006–08 (thousands of hectares)

Rank	Crop	Percent of total	Harvest area
	Total	100.0	6,310
1	Cocoa beans	26.6	1,678
2	Cassava	12.6	797
3	Maize	12.1	764
4	Groundnuts	7.4	470
5	Sorghum	5.3	333
6	Oil palm fruit	4.9	311
7	Plantains	4.8	301
8	Yams	4.7	299
9	Taro cocoyams	4.1	261
10	Millet	3.0	190

Source: FAOSTAT (FAO 2010).
Note: All values are based on the three-year average for 2006–08.

TABLE 6.4 Value of production of leading agricultural commodities in Ghana, 2005–07 (millions of US$)

Rank	Crop	Percent of total	Value of production
	Total	100.0	6,695.6
1	Cassava	17.8	1,189.4
2	Yams	17.2	1,153.1
3	Plantains	15.1	1,014.3
4	Cocoa beans	10.3	689.7
5	Taro cocoyams	7.2	482.1
6	Groundnuts	5.5	368.3
7	Maize	5.2	349.9
8	Chilies and peppers	3.3	219.7
9	Chilies and peppers	2.4	158.9
10	Rice	2.3	155.5

Source: FAOSTAT (FAO 2010).
Note: All values are based on the three-year average for 2005–07. US$ = US dollars.

TABLE 6.5 Consumption of leading food commodities in Ghana, 2003–05 (thousands of metric tons)

Rank	Food	Percent of total	Food consumption
	Total	100.0	15,980
1	Cassava	28.4	4,537
2	Yams	15.2	2,433
3	Plantains	14.1	2,250
4	Other roots and tubers	8.0	1,286
5	Maize	5.6	899
6	Rice	3.2	513
7	Pelagic fish	2.7	426
8	Other vegetables	2.3	363
9	Oranges and mandarins	2.3	363
10	Wheat	2.1	332

Source: FAOSTAT (FAO 2010).
Note: All values are based on the three-year average for 2003–05.

crops, the crops were ranked higher in importance (second and third) because of the value of the products. Cassava is the most widely consumed crop in Ghana. The classification of food commodities by quantities consumed indicates their importance in the diets of Ghanaians: cassava, yams, plantains, maize, and rice rank as the five most important crops produced and consumed in Ghana.

The next four figures show the estimated yield and growing areas of key crops. Figure 6.9 shows that cassava is cultivated in all regions of Ghana—with the exception of the Upper East region—with yields ranging from 7 to more than 10 metric tons per hectare and the main areas of production concentrated in the forest zone.[1] Yam cultivation is carried out across all regions except the Upper East region and is concentrated mainly in the forested and savanna zones as well as a few areas in the transition zone (Figure 6.10).

Rainfed plantain and banana cultivation is concentrated in the forest zone, with yields of 7 tons and above (Figure 6.11). There is some potential for good plantain and banana cultivation in the transition zone but almost none in the savannah zones.

Figure 6.12 shows that rainfed maize is produced in almost all parts of the country, with the major producing areas in the transition and savanna zones. The highest maize yield levels are between 1 and 2 tons per hectare.

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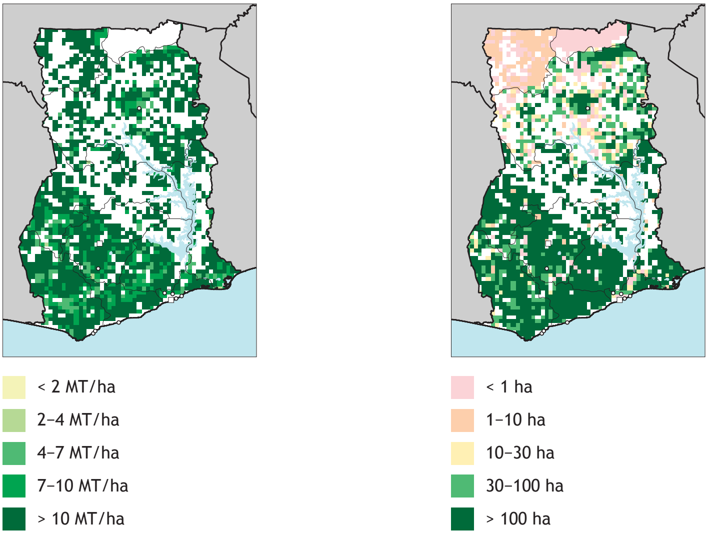
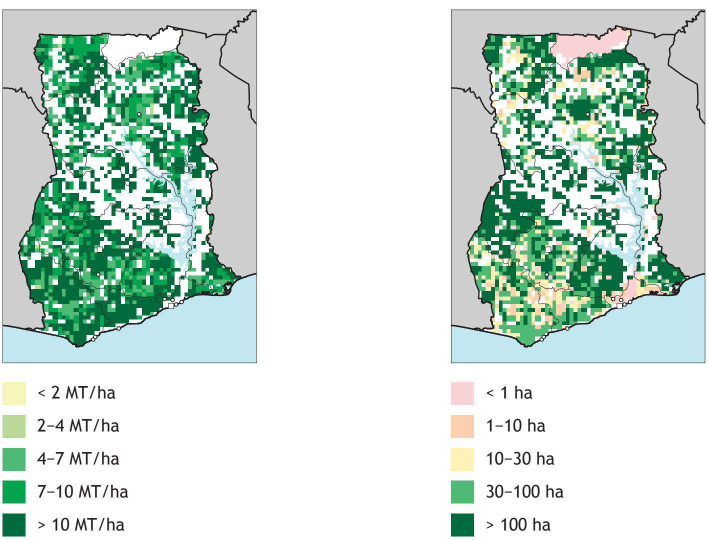
1 All tons are metric tons.

FIGURE 6.9 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed cassava in Ghana, 2000



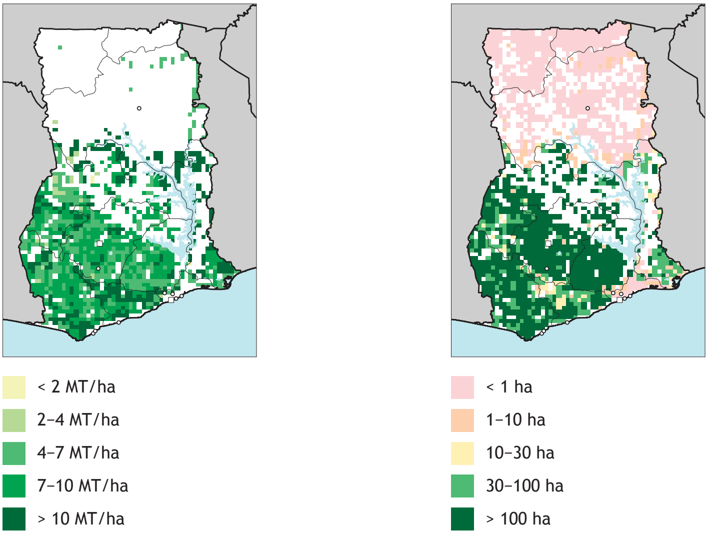
Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 6.10 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed yams and sweet potatoes in Ghana, 2000



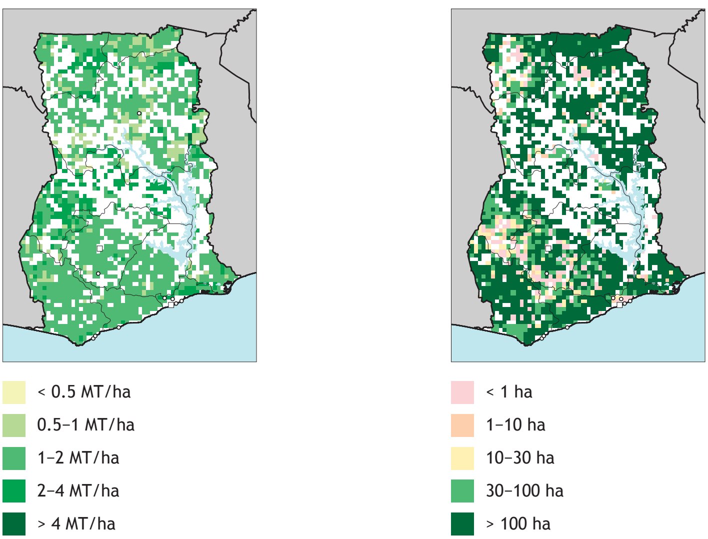
Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 6.11 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed plantains and bananas in Ghana, 2000



Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 6.12 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed maize in Ghana, 2000



Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

Economic and Demographic Scenarios

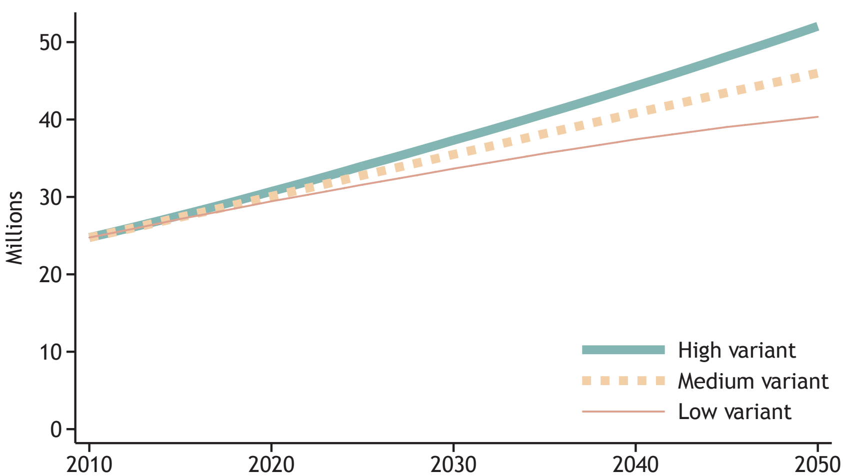
Population

Figure 6.13 shows population projections for Ghana by the United Nations (UN) population office through 2050. The high variant scenario shows Ghana's population reaching over 50 million by 2050, the medium variant 45 million, and the low variant fewer than 40 million. The low variant and high variant can be viewed as the best-case and worst-case scenarios in terms of population growth. Even in the best-case scenario, Ghana's population is shown as increasing by 50 percent within a 40-year period. The implications of such a population growth rate for overall national development could be significant with regard to the provision of required infrastructure and services.

Income

Figure 6.14 presents three overall scenarios for the gross domestic product (GDP) of Ghana derived by combining three GDP scenarios with the three population scenarios of Figure 6.13 (based on UN population data). The

FIGURE 6.13 Population projections for Ghana, 2010–50

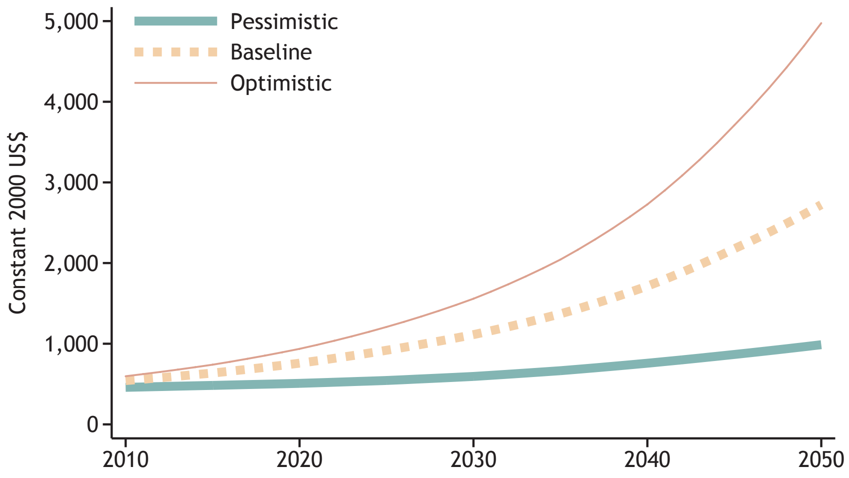


Source: UNPOP (2009).

optimistic scenario combines high GDP with low population scenarios for all countries, the baseline scenario combines the medium GDP projection with the medium population scenario, and the pessimistic scenario combines the low GDP scenario with the high population scenario. The economic modeling in the next section uses these scenarios as well.

The optimistic scenario curve shows the possibility of Ghana's per capita GDP reaching about US$5,000 by 2050, whereas the baseline and pessimistic scenarios show a possible GDP of US$2,800 and US$1,000, respectively. The optimistic scenario is the only one that supports Ghana's vision of attaining middle-income status by 2020, with per capita GDP of US$1,000. Any condition that reduces the economic (GDP) growth rate or increases the population growth rate will effectively limit the achievement of this development goal.

FIGURE 6.14 Gross domestic product (GDP) per capita in Ghana, future scenarios, 2010–50



Sources: Computed from GDP data from the World Bank Economic Adaptation to Climate Change project (World Bank 2010), from the Millennium Ecosystem Assessment (2005) reports, and from population data from the United Nations (UNPOP 2009).
Note: US$ = US dollars.

Biophysical Scenarios

Climate Scenarios

Figure 6.15 shows precipitation changes in Ghana in the four downscaled general circulation models (GCMs) using the A1B scenario.[2] The CNRM-CM3 and ECHAM 5 GCMs show that there will be little change in annual precipitation in most regions of the country.[3] CNRM-CM3 shows an increase in the extreme southern part of the country, while ECHAM 5 shows an increase in the southeastern part of the country. According to CSIRO Mark 3, there are possibilities of general reduction in precipitation across the country: –200 to –100 millimeters per year in the middle belt, –100 to –50 millimeters in the northern savanna zone, and –50 to +50 millimeters in the southwestern corner.[4] MIROC 3.2 shows decreased precipitation in the south and increased precipitation in the north.[5] The maps for the latter two GCMs indicate a challenging future for Ghanaian agriculture as long as it remains basically rainfed.

Figure 6.16 shows the change in average daily maximum temperature in the A1B scenario according to various GCMs. The CNRM-CM3 GCM shows a uniform increase in temperature of 2.0°–2.5°C across the country, while the ECHAM 5 GCM shows an increase of 1.5°–2.0°C in most parts of the country but predicts temperatures like those in the CNRM-CM3 GCM for the upper northern part of the country. The CSIRO Mark 3 GCM shows an increase of 1.5°–2.0°C in the north and 1.0°–1.5°C in the south, and the MIROC 3.2 medium-resolution GCM shows a general moderate increase of 1.0°–1.5°C in most parts of the country, with a portion of the southwestern part of the country seeing an increase of 0.5°–1.0°C.

Crop Physiological Response to Climate Change

The effect of climate change on key crops is mapped in the next three figures. The comparison is between the crop yields with 2050 climate and yields with unchanged (2000) climate.

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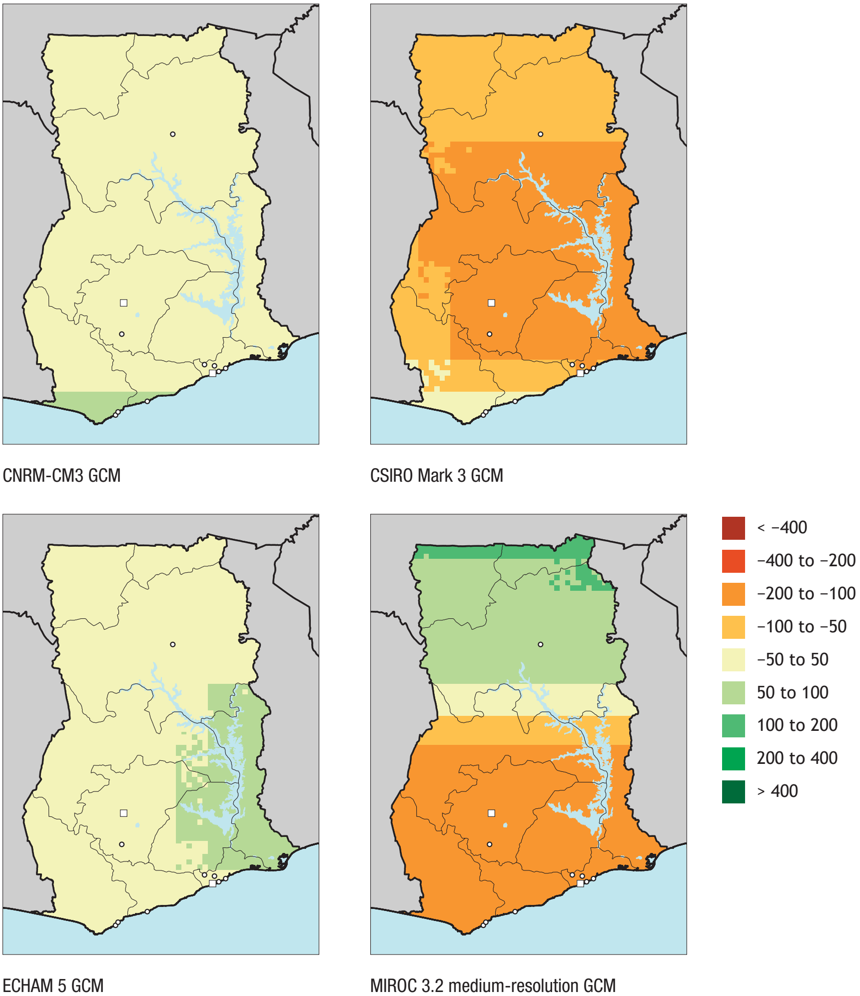
2 The A1B scenario is a greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources.

3 CNRM-CM3 is National Meteorological Research Center–Climate Model 3. ECHAM 5 is a fifth-generation climate model developed at the Max Planck Institute for Meteorology in Hamburg.

4 CSIRO Mark 3 is a climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation.

5 MIROC 3.2 is the Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

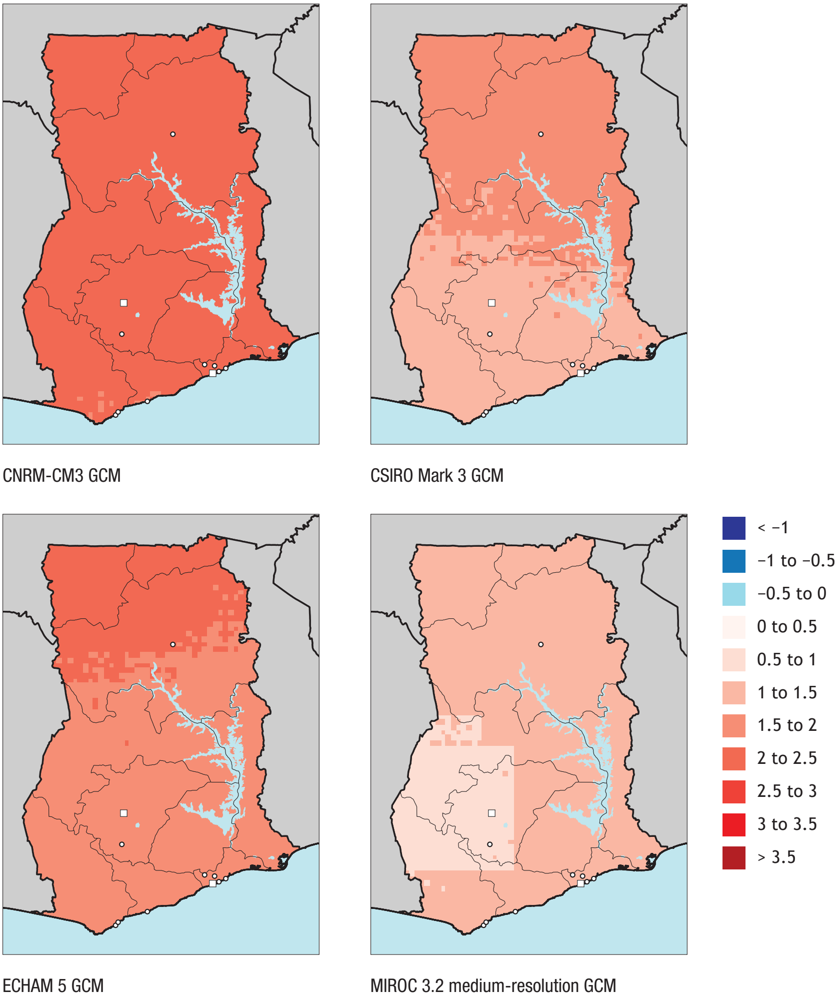
FIGURE 6.15 Changes in mean annual precipitation in Ghana, 2000–2050, A1B scenario (millimeters)



Source: Authors' calculations based on Jones, Thornton, and Heinke (2009).

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

FIGURE 6.16 Change in the monthly mean maximum daily temperature in Ghana for the warmest month, 2000–2050, A1B scenario (°C)



Source: Authors' calculations based on Jones, Thornton, and Heinke (2009).

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

Figure 6.17 shows a general decrease in maize yield across the country. CNRM-CM3 shows relatively less area affected compared to the other three models. The other models also show a yield loss greater than 25 percent in various parts of the country.

The extent and degree of the rice yield loss (Figure 6.18) are relatively less than those for maize, with variation among the models. CNRM-CM3 shows more positive rice yield gain than do the other three models.

All the models show a reduction in rainfed groundnut yields across the country in varying degrees (Figure 6.19). CNRM-CM3 shows relatively less area with a yield loss of 5 to 25 percent and the least area with a yield loss greater than 25 percent. All models show a possible increase in yield in some areas of northern Ghana. ECHAM 5 shows areas with a yield loss greater than 25 percent concentrated in the northern region; both CSIRO Mark 3 and MIROC 3.2 show areas with a yield loss greater than 25 percent limited to the central and lower part of the country.

Agricultural Vulnerability Scenarios (Crop-Specific)

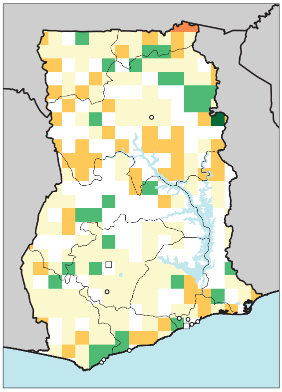
Figure 6.20 shows the impact of future GDP and population scenarios on under-five malnutrition rates in Ghana. The box-and-whisker plots in the figure indicate the range of climate scenario effects. High GDP growth along with low population growth should significantly reduce the number and percentage of malnourished children under age five; a low GDP growth rate with high population growth would have the opposite effect. The vulnerability of the economies of developing countries such as Ghana to shocks from external market fluctuations could be a major constraint to realizing dramatic improvements in nutrition.

Figure 6.21 shows the available kilocalories per capita, illustrating the influence of per capita GDP and population growth rates on availability of calories. The best-case scenario of high GDP growth with low population growth provides for higher availability of calories than the pessimistic scenario, which pegs the availability of calories at 2,000 after year 2020.

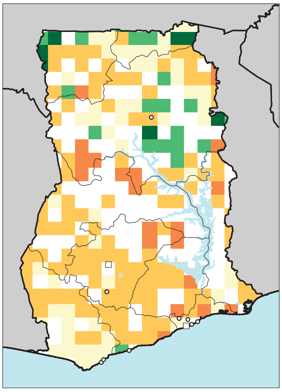
Human Vulnerability Scenarios

The next four figures show simulation results associated with key agricultural crops in Ghana. The figure for each featured crop has five graphs: production, yield, area under cultivation, net exports, and world price.

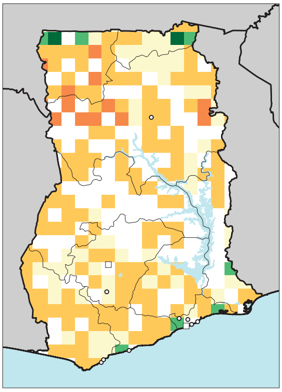
FIGURE 6.17 Yield change under climate change: Rainfed maize in Ghana, 2010–50, A1B scenario



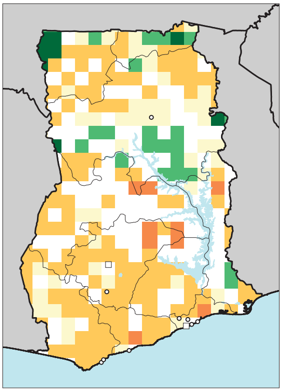
CNRM-CM3 GCM



CSIRO Mark 3 GCM



ECHAM 5 GCM



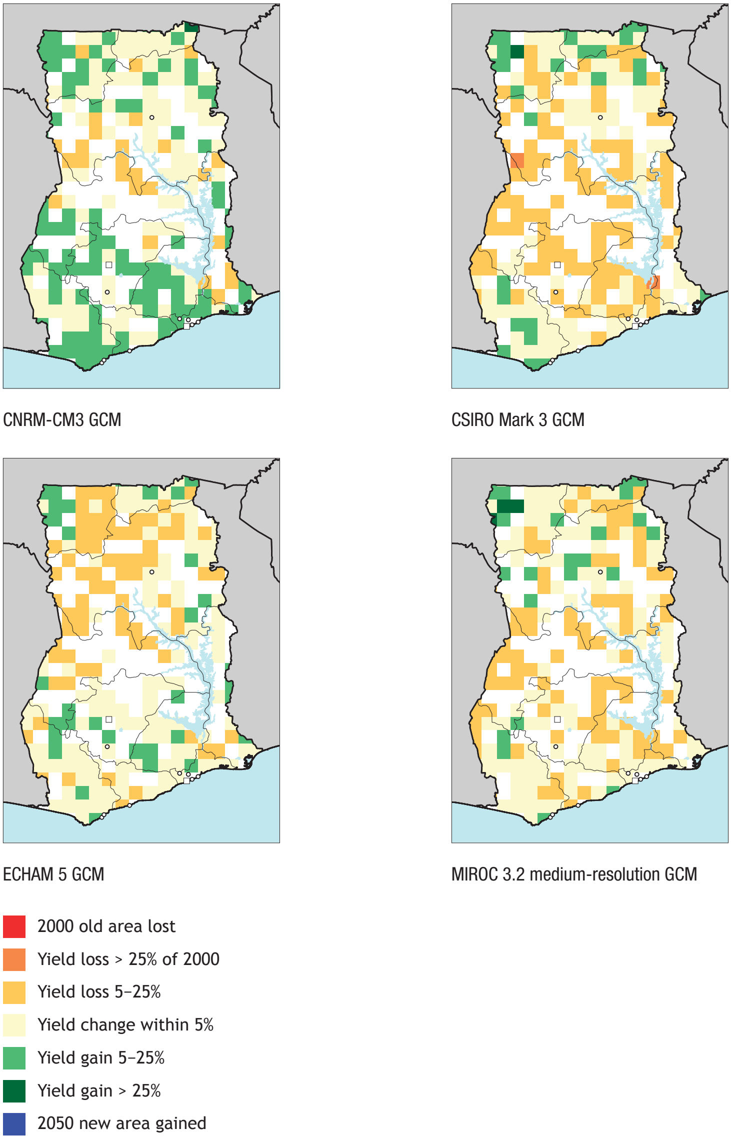
MIROC 3.2 medium-resolution GCM

- 2000 old area lost
- Yield loss > 25% of 2000
- Yield loss 5–25%
- Yield change within 5%
- Yield gain 5–25%
- Yield gain > 25%
- 2050 new area gained

Source: Authors' estimates.

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

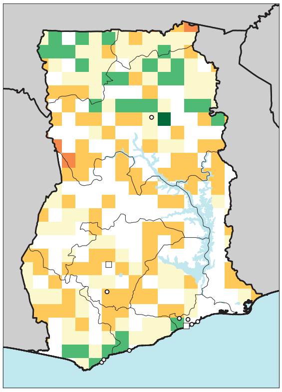
FIGURE 6.18 Yield change under climate change: Rainfed rice in Ghana, 2010–50, A1B scenario



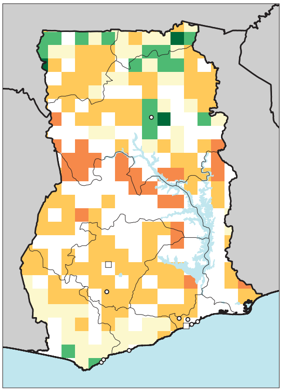
Source: Authors' estimates.

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

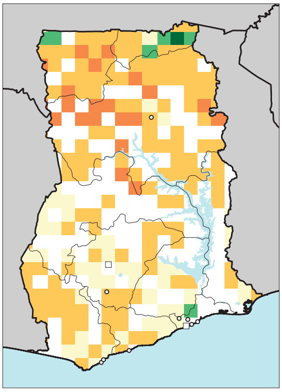
FIGURE 6.19 Yield change under climate change: Rainfed groundnuts in Ghana, 2010–50, A1B scenario



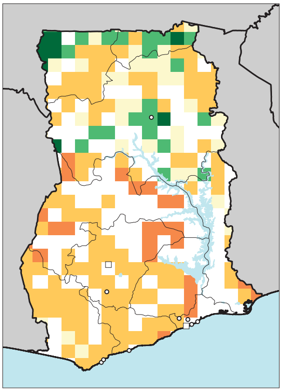
CNRM-CM3 GCM



CSIRO Mark 3 GCM



ECHAM 5 GCM



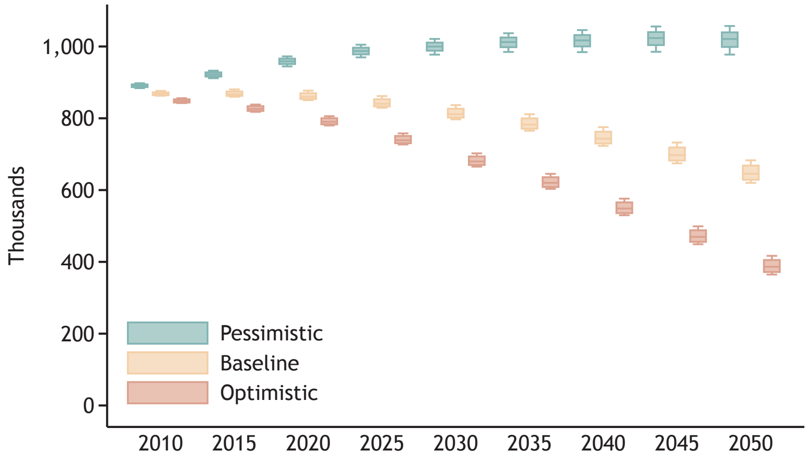
MIROC 3.2 medium-resolution GCM

- 2000 old area lost
- Yield loss > 25% of 2000
- Yield loss 5–25%
- Yield change within 5%
- Yield gain 5–25%
- Yield gain > 25%
- 2050 new area gained

Source: Authors' estimates.

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

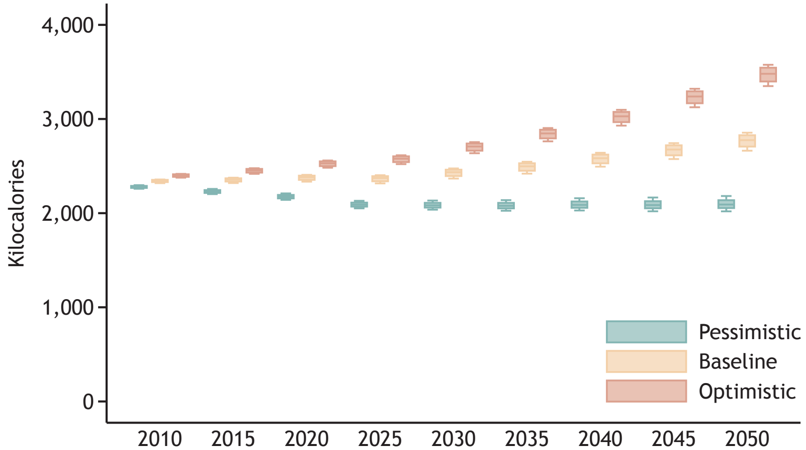
FIGURE 6.20 Number of malnourished children under five years of age in Ghana in multiple income and climate scenarios, 2010–50



Source: Based on analysis conducted for Nelson et al. (2010).

Note: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios.

FIGURE 6.21 Kilocalories per capita in Ghana in multiple income and climate scenarios, 2010–50



Source: Based on analysis conducted for Nelson et al. (2010).

Note: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios.

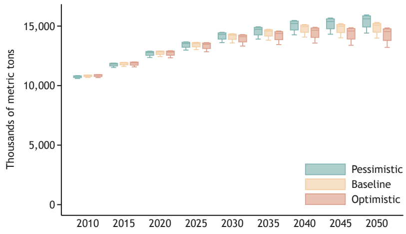
Figure 6.22 shows the impact of changes in GDP and population on cassava in Ghana. The production of cassava could increase as a result of an increase in yield, while land area is not expected to change very much. The trend is similar for all the scenarios. The world market price for cassava in 2050 appears higher in the pessimistic scenario than in the optimistic scenario. Cassava imports in all three scenarios could increase minimally until 2025, after which imports may increase in all scenarios. The level of certainty of the export volume diminishes progressively in all the scenarios as the effects of climate change become greater (as shown by increasingly broad percentile spreads).

The production of yams and sweet potatoes increases in all three scenarios until 2050 (Figure 6.23). The yield per hectare is also shown to increase, while the land area will remain virtually constant. The major difference among the three scenarios is that in the optimistic scenario the boxes indicate little or no spread, whereas the spreads for the other two scenarios widen toward 2050, with distributions skewed toward the 75th percentile. Exports are shown to increase starting in 2010, peaking between 2030 and 2035 and then declining until 2050. Greater uncertainty is shown in the baseline scenario than in the pessimistic or the optimistic scenario.

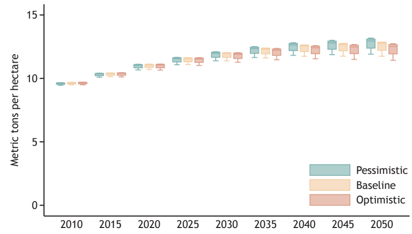
Maize production and yield are projected to increase in Ghana in all scenarios from 2010 to 2050 (Figure 6.24), with slight increases in spreads for all three scenarios. Similar to what is seen in the case of roots and tubers, the increase in total production is predicted to be driven primarily by productivity increases rather than increases in area under production, though we note here an increase in area of more than 10 percent. Maize exports are expected to increase until 2035 or 2040 and decrease thereafter in all scenarios. For all scenarios, the spread of values increases from 2010 to 2050. Values in the pessimistic scenario are higher throughout the period under consideration. It appears that the world market price of maize will rise throughout the period, with slight increases in the range of values. The values of the baseline scenario appear a little higher than those of the other two scenarios for most years.

There is very little difference between scenarios in predictions for the yield of groundnuts (Figure 6.25). We note an across-the-board increase in yield of around 50 percent between 2010 and 2050. All scenarios predict that the area planted in groundnuts will be mostly unchanged through 2025, after which it will fall slightly more rapidly in the optimistic scenario than in the baseline scenario, in which, in turn, it will fall more rapidly than in the pessimistic scenario, which shows virtually no change from 2010, dropping only a small amount. Together, the yield and area changes will result in an increase

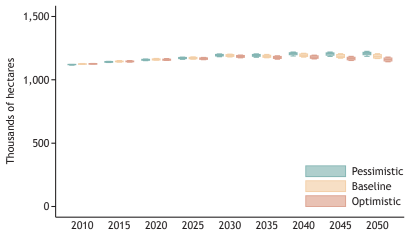
FIGURE 6.22 Impact of changes in GDP and population on cassava in Ghana, 2010–50



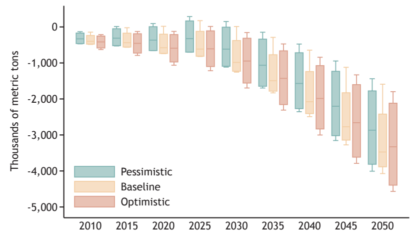
Production



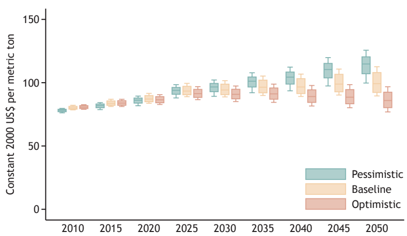
Yield



Area



Net exports

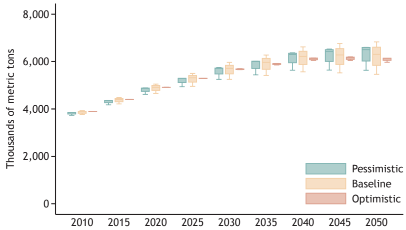


Prices

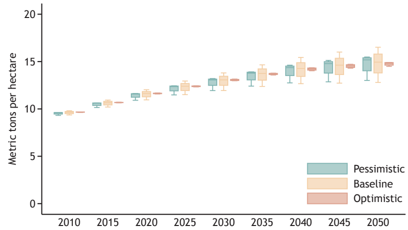
Source: Based on analysis conducted for Nelson et al. (2010).

Notes: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios. GDP = gross domestic product; US$ = US dollars.

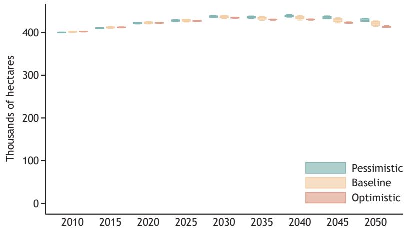
FIGURE 6.23 Impact of changes in GDP and population on yams and sweet potatoes in Ghana, 2010–50



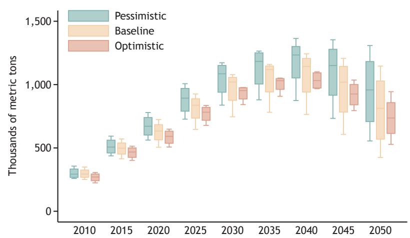
Production



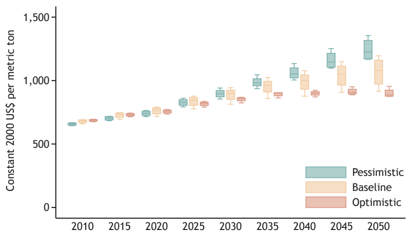
Yield



Area



Net exports

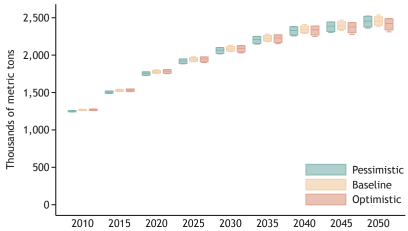


Prices

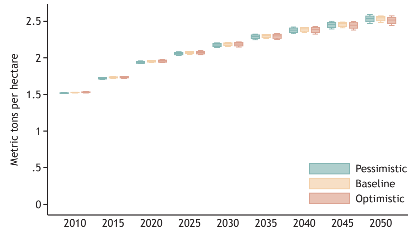
Source: Based on analysis conducted for Nelson et al. (2010).

Notes: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios. GDP = gross domestic product; US$ = US dollars.

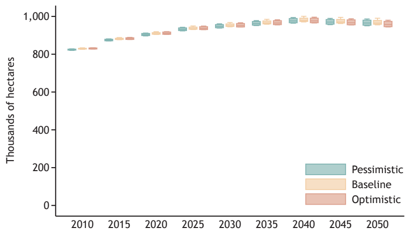
FIGURE 6.24 Impact of changes in GDP and population on maize in Ghana, 2010–50



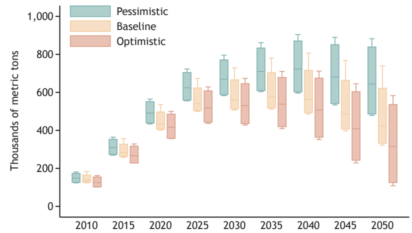
Production



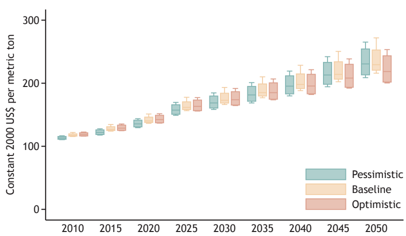
Yield



Area



Net exports

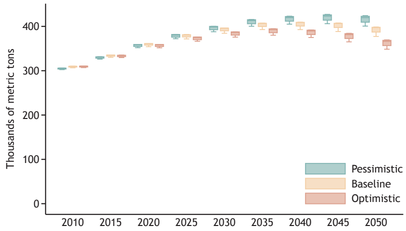


Prices

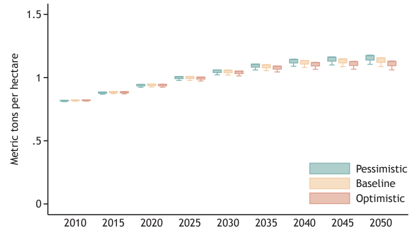
Source: Based on analysis conducted for Nelson et al. (2010).

Notes: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios. GDP = gross domestic product; US$ = US dollars.

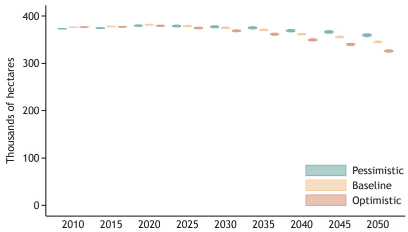
FIGURE 6.25 Impact of changes in GDP and population on groundnuts in Ghana, 2010–50



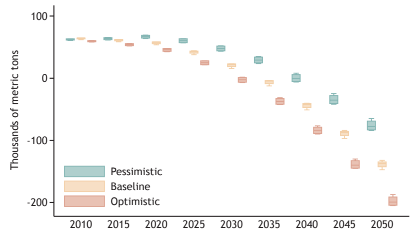
Production



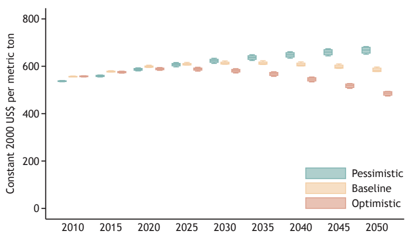
Yield



Area



Net exports



Prices

Source: Based on analysis conducted for Nelson et al. (2010).

Notes: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios. GDP = gross domestic product; US$ = US dollars.

in production of almost one-third between 2010 and 2050 in the pessimistic scenario, an increase of 25 percent in the baseline scenario, and an increase of around 15 percent in the optimistic scenario. Over the time period, prices rise slightly in the pessimistic scenario, baseline prices will be largely unchanged, and prices in the optimistic scenario will fall slightly. Trade will shift from exports in 2010 to imports in 2050, with the level of imports more than twice as high in the optimistic scenario as in the pessimistic scenario.

Conclusions and Policy Recommendations

The various scenarios have implications for the future development of Ghana, especially in the areas of food security and natural resource management. Ghana's agriculture remains basically rainfed and therefore highly vulnerable to the effects of climatic change. Potentially high temperatures, along with decreased precipitation, could have serious implications for the yield and production of major food security crops like maize, rice, and groundnuts, as shown in this chapter. It is therefore important for food security policies to effectively address anticipated climate change effects.

In two of the four models considered, climate change is anticipated to decrease water availability for rainfed agriculture. The government could consider expanding irrigation infrastructure (thus increasing productivity per unit of water) in order to support the year-long production of a wider range of crops.

Reliable weather and climate information is important in enabling farmers to adapt to current weather events. The government could consider improving collaboration between agricultural and meteorological institutions to provide better and better-focused climatic information to farmers. In addition, research could quicken the development of climate-adaptive technologies for enhancing rainfed agriculture.

High population growth in urban areas results in higher demand for food, requiring increased and timely supply from the rural areas. Reliable transportation can reduce travel times between the cities and the production centers. Therefore, there is a need to improve the road infrastructure and to consider developing alternative transport systems to link rural and urban centers. Additionally, city authorities could consider establishing zoning regulations to create green areas that could support periurban agriculture to help feed the urban populations.

Ghana has great potential in the area of ecotourism; however, this is being eroded by massive degradation of natural resources, which could be exacerbated by climate change effects. Increasing the number of globally recognized protected areas has the potential of increasing the vegetative cover of the country while providing opportunities for ecotourism and thus additional livelihood opportunities for rural communities. However, the road networks leading to most of the protected areas need improvement to facilitate access by tourists.

Although climate change is predicted to have mostly negative consequences for agriculture and although population growth is likely to present additional challenges for food security, housing, and other forms of infrastructure, the projections for economic growth in Ghana suggest that, with wise investment in physical infrastructure and the adoption of sound policies for agricultural adaption to climate change as well as population growth, Ghana can look forward to a bright future. Yet we note that if economic growth takes place at a rate similar to that of the pessimistic scenario, there will be much less room for error, and poor decisions in regard to public investment or public policy could have much more serious consequences.

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