Chapter 4

BURKINA FASO

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Burkina Faso is a landlocked country in West Africa covering about 274,000 square kilometers. It is bordered by the Republic of Mali on the north and west; by Cote d'Ivoire on the Southwest; by Ghana, Togo, and Benin on the South; and by Niger on the east. The country has a dry tropical climate with two contrasting seasons. The rainy season generally lasts from May to October, but its duration decreases progressively from the southwest, amounting to only three months in the northern part of the country.

Agriculture accounts for 40 percent of the gross domestic product (GDP) and 60 percent of the total exports of Burkina Faso. Its cropped area is 3.5–4.0 million hectares, representing about 13 percent of the country's total area and one-third of the arable land. Rainfed agriculture dominates, with largely rudimentary agricultural techniques prevailing among small-scale farmers. Crop production is more diversified in the Sudanian zone (in the southwest), with a variety of roots and tubers (yams, sweet potatoes, and cocoyams), fruits (mangoes, bananas, and citrus fruits), cashews, and sugarcane. The major cash crops are cotton, groundnuts, cowpeas, and sesame.

Review of the Current Situation

On the basis of its annual average distribution of rainfall, the country can be divided into three ecoclimatic zones: (1) the Sahelian zone, where the total annual rainfall is below 600 millimeters and occurs over a period of three to four months; (2) the Sudan-Sahelian zone, with total rainfall of 600–900 millimeters during four to five months of the year; and (3) the Sudanian zone, where the annual average rainfall is more than 900 millimeters and occurs in five to six months of the year.

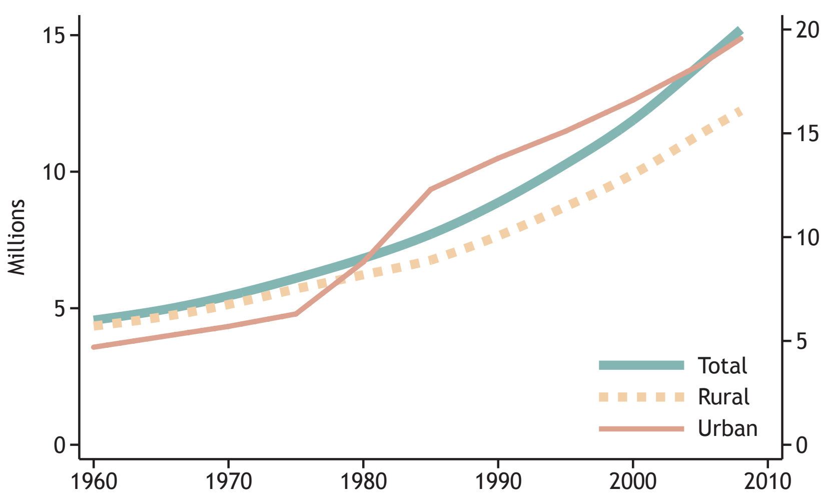
Three river basins drain the country: the Volta basin (63 percent of the total area), the Niger basin (30 percent), and the Comoe basin (7 percent). This hydrographic network is quite dense, but most of the rivers are not permanent, limiting the possibilities for irrigation. Several dams and small reservoirs support agricultural activities in the country.

Population

The most recent general population census, held in 2006, estimated the population of Burkina Faso at 14.1 million, with an average density of 51.8 inhabitants per square kilometer (Burkina Faso, INSD 2009). The majority of the population is young, with more than 30 percent under 10 years of age and 46.6 percent under 15 years. Figure 4.1 shows the numbers of the total and rural population (left axis) as well as the share of urban population (right axis). The percentage of the population living in urban areas increased sharply in the mid-1970s, possibly as a result of the severe drought in 1972/1973, which affected the livelihoods of farm families, forcing many to go to the urban areas for alternative livelihoods. Another episode of drought occurred between 1983 and 1987.

Population migration as a consequence of climate variability and change has been clearly identified by the Burkina Faso National Adaptation Programme of Action initiative (Burkina Faso, MECV 2007). However, the

FIGURE 4.1 Population trends in Burkina Faso: Total population, rural population, and percent urban, 1960–2008



Source: World Development Indicators (World Bank 2009).

TABLE 4.1 Population growth rates in Burkina Faso, 1960–2008 (percent)

Decade	Total growth rate	Rural growth rate	Urban growth rate
1960–69	1.7	1.6	3.7
1970–79	2.3	2.0	6.4
1980–89	2.6	2.0	7.3
1990–99	2.9	2.6	4.8
2000–2008	3.1	2.7	5.1

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

urban population is currently only about 20 percent of the population of the country, less than most of the countries in the region. The total growth rate of the population, at 4.1 percent per year (Table 4.1), seems to be higher than the growth rate of the economy.

Table 4.1 provides additional information concerning rates of population growth in Burkina Faso. Uncharacteristically for any nation, we see that not only the population but also the growth rate has increased in every decade since the 1960s. Although the rural growth rate lags the urban growth rate, it is still increasing at a steady rate.

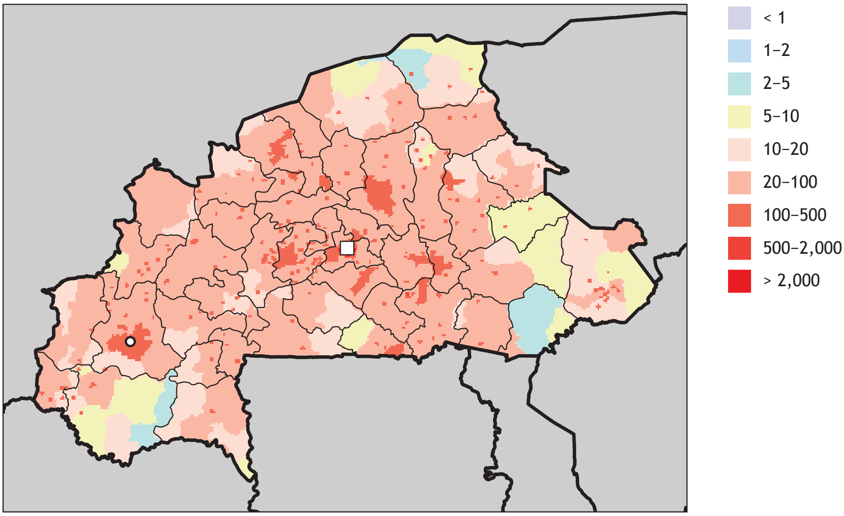
Figure 4.2 shows the geographic distribution of the population in Burkina Faso. Population density is relatively higher in the provinces along the White Volta River and those along the principal road from Ghana through the capital city to Mali. Bobo-Dioulasso Province, in the western part of the country, also shows a relatively high population density, hosting the second capital city.

Income

The share of income earned in agriculture shows the importance of the agricultural sector in the economy of Burkina Faso. Figure 4.3 shows trends in GDP per capita and the proportion of GDP from agriculture.

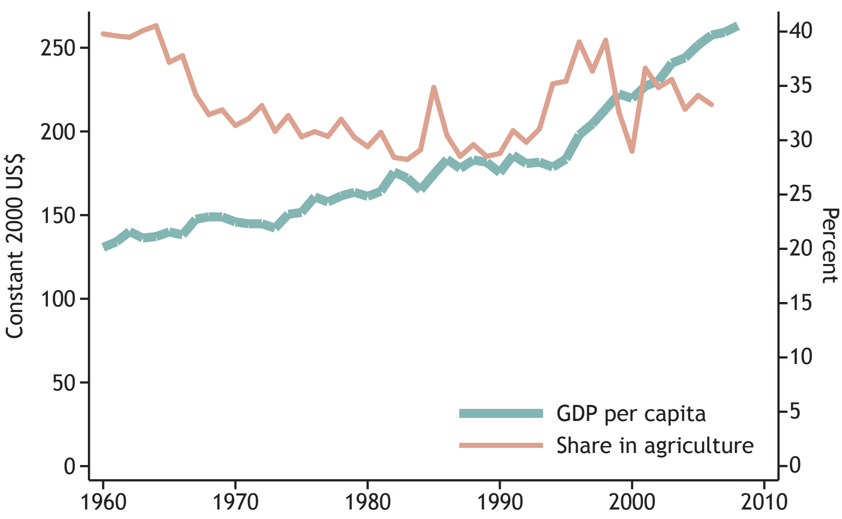
Per capita GDP has generally increased since 1960. However, the increase was relatively small until the mid-1990s, increasing from about $130 to about $180 between 1960 and 1994. The rate of growth increased around 1994, with GDP per capita rising to $220 in 2000 and then to more than $260 in 2008. The improvement in per capita GDP could be explained by the devaluation of the CFA franc in January 1994, more favorable climatic conditions, and the boom in the mineral sector. The share of GDP from agriculture has generally been between 30 and 40 percent, declining from 1960 to the early 1980s, rising in the early and mid-1990s, and again declining after 1998 due to the growth in the service sector (see Figure 4.3).

FIGURE 4.2 Population distribution in Burkina Faso, 2000 (persons per square kilometer)



Source: CIESIN et al. (2004).

FIGURE 4.3 Per capita GDP in Burkina Faso (constant 2000 US$) and share of GDP from agriculture (percent), 1960–2008



Source: World Development Indicators (World Bank 2009).

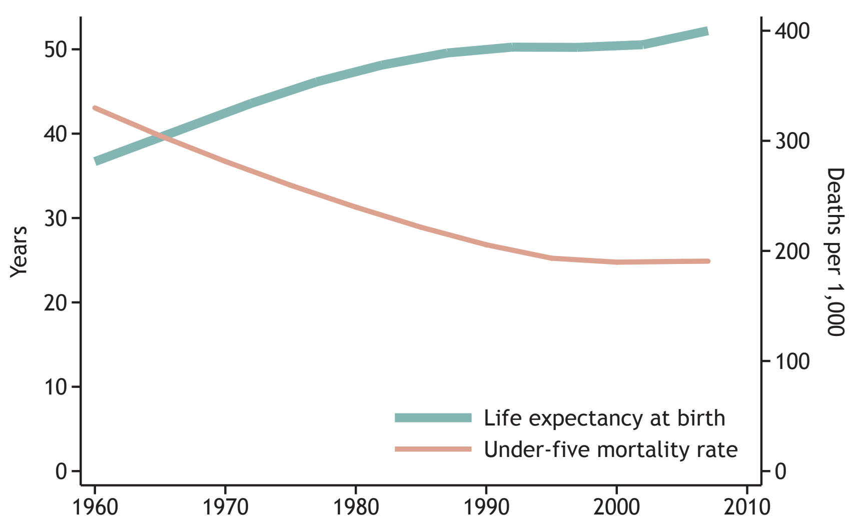
Notes: GDP = gross domestic product; US$ = US dollars.

Vulnerability to Climate Change

Vulnerability is the inability to recover from stress. Poor people are vulnerable to many different kinds of stresses because they lack the financial resources to respond. In agriculture, poor people are particularly vulnerable to the stresses of an uncertain climate. At the national level, vulnerability arises from the interactions among population and income growth and the availability or scarcity of natural and manufactured resources.

Vulnerability has many dimensions. In this chapter the focus is on income and then nonincome indicators of life expectancy at birth and the under-five mortality rate displayed in Figure 4.4. Table 4.2 provides some data on additional indicators of vulnerability and resiliency to economic shocks: the level of education of the population, literacy, and the concentration of labor in poorer or less dynamic sectors. There is a significant drop in secondary school enrollment compared to that for primary school in Burkina Faso. The adult literacy rate is also very low. Agriculture employs the bulk of the population, who are generally resource poor and produce less than a subsistence level. The lack of financial resources severely limits the ability of these poor farmers to use much-needed inputs like the improved seeds, fertilizer, and pesticides that will ensure increased agricultural production.

FIGURE 4.4 Well-being indicators in Burkina Faso, 1960–2008



Source: World Development Indicators (World Bank 2009).

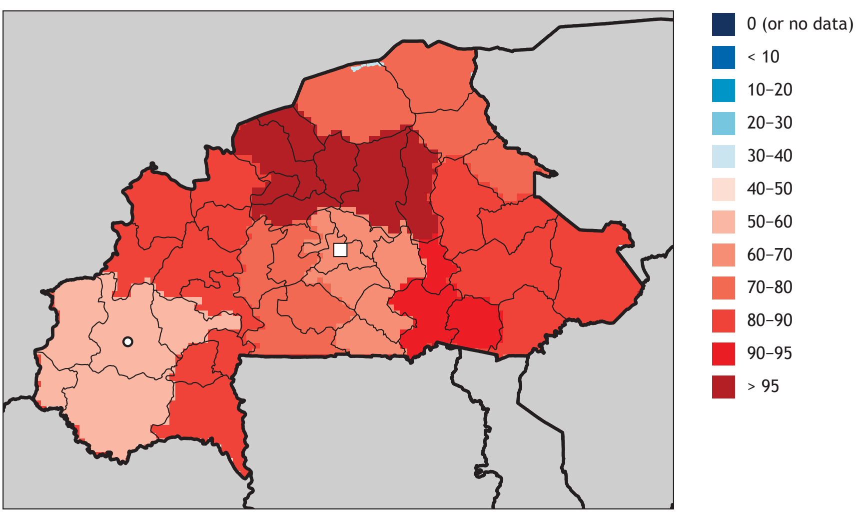
TABLE 4.2 Education and labor statistics for Burkina Faso, 1990s and 2000s

Indicator	Year	Percent
Primary school enrollment (percent gross, three-year average)	2008	71.0
Secondary school enrollment (percent gross, three-year average)	2008	18.1
Adult literacy rate	2007	28.7
Percent employed in agriculture	1994	88.8
Under-five malnutrition (weight for age)	2003	35.2

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

Figure 4.4 shows two noneconomic correlates of poverty: life expectancy and under-five mortality. This figure shows a general improvement in both of these well-being indictors. Life expectancy at birth increased from less than 40 years in 1960 (the year of Burkina Faso's independence) to 53 years in 2008. During the same period, the under-five mortality rate decreased from more than 300 to fewer than 200 per 1,000 in the mid-1990s. Among the important factors contributing to this increase has been the control of diseases that affect children, like measles and poliomyelitis, particularly through vaccination.

FIGURE 4.5 Poverty in Burkina Faso, circa 2005 (percentage of population below US$2 per day)



Source: Wood et al. (2010).

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

Figure 4.5 shows the proportion of the population in Burkina Faso living on less than US$2 (US dollars) per day, which exceeds 50 percent of the population in all parts of the country. Poverty is relatively less pronounced in the provinces adjacent to the two major cities and more severe in the provinces with higher population densities.

Review of Land Use and Agriculture

Land Use Overview

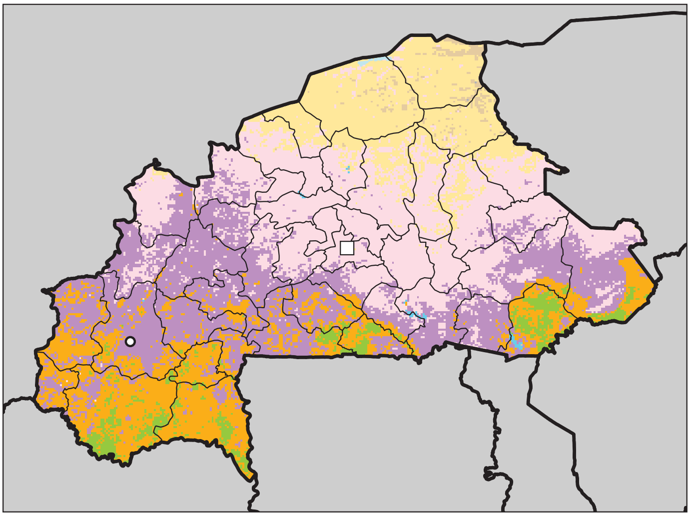
Figure 4.6 shows the land cover and land use in Burkina Faso as of 2000. Natural vegetation varies with the three ecoclimatic zones in the country—steppe in the north, shrubs and annual grasses in the center, and various trees and perennial grasses in the south and southwest (Guinko 1984). The northern, Sahelian region is characterized variously by herbaceous cover, closed–open vegetation, and scrubland steppe. It is mainly devoted to pasture, but due to the harsh climate and overgrazing the vegetation is often thorny and stunted. The most common species found in this area include *Acacia* spp., *Balanitesaegyptiaca, Bauhinia rufescens,* and *Ziziphusmauritiania*. The annual grasses form a discontinuous cover except in the clayey soil depressions.

The Sudan region of Burkina Faso, in the southwest, is characterized by species like Shea trees (*Vitellaria paradoxa*), *nere* (*Parkia biglobosa*), and other Sudan species. Perennial grasses (*Andropogongayanus* and *Cymbopogon* spp.) are abundant; during the rainy season, they form a continuous cover. The Sudan–Guinean zone is characterized by ligneous species whose density and height are significantly greater than in the other two domains. Most of the species found in the Sudanian zone are present in this region. Characteristic species here include *Burkea africana, Isoberlinia doka,* and *Detarium microcarpum.* There are also several forest galleries along the perennial rivers.

Figure 4.7 shows protected areas, including parks and reserves. These fragile environmental areas may also be important for the tourism industry.

Figure 4.8 shows travel time to the larger cities, which offer potential markets for agricultural products. Policymakers need to keep in mind the importance of transport costs when considering potential for agricultural expansion. Fertile unused land that is far from markets represents potential areas of expansion only if transportation infrastructure is in place (and, of course, if expansion does not conflict with preservation priorities as shown in Figure 4.7). In general, the travel time to major towns and cities is 1–3 hours. There is a

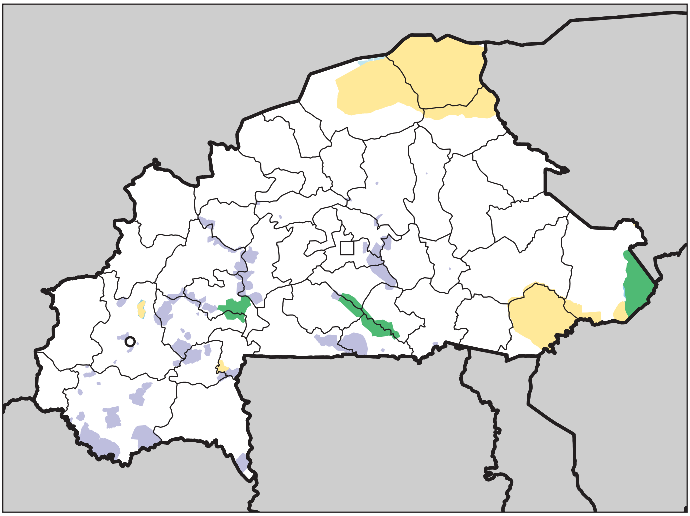
FIGURE 4.6 Land cover and land use in Burkina Faso, 2000



- 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 4.7 Protected areas in Burkina Faso, 2009



- Ia: Strict Nature Reserve
- Ib: Wilderness Area
- II: National Park
- III: National Monument
- IV: Habitat / Species Management Area
- V: Protected Landscape / Seascape
- VI: Managed Resource Protected Area
- Not applicable
- Not known

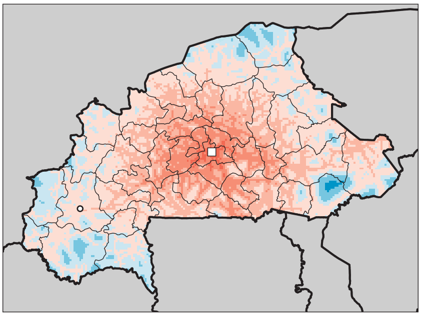
Sources: Protected areas are from the World Database on Protected Areas (UNEP and IUCN 2009). Water bodies are from the World Wildlife Fund's Global Lakes and Wetlands Database (Lehner and Döll 2004).

good network of roads around the first and second capital cities. Only in Pama Province is the road network relatively underdeveloped.

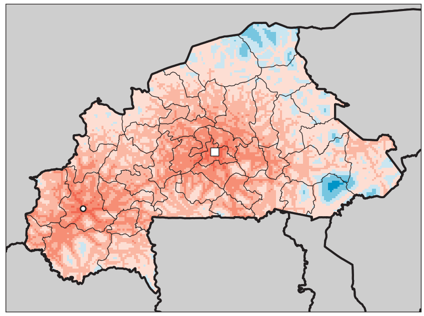
Agriculture Overview

The next three tables show key agricultural commodities in terms of area harvested (Table 4.3), the value of the harvest (Table 4.4), and the provision of food for human consumption (ranked by weight) (Table 4.5). Sorghum and millet are the major staples in Burkina Faso, while cotton is the major cash crop. Maize, cowpeas, and groundnuts are also important crops grown and consumed in the country.

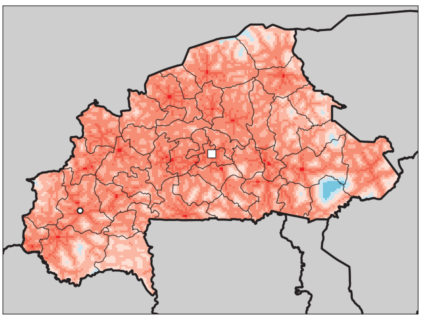
FIGURE 4.8 Travel time to urban areas of various sizes in Burkina Faso, circa 2000



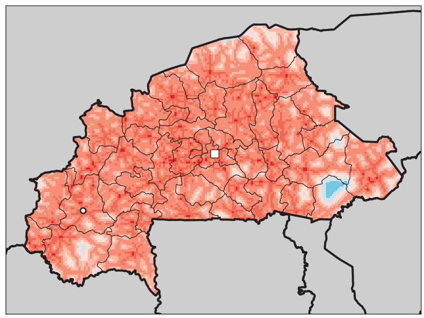
To cities of 500,000 or more people



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 4.3 Harvest area of leading agricultural commodities in Burkina Faso, 2006–08 (thousands of hectares)

Rank	Crop	Percent of total	Harvest area
	Total	100.0	5,316
1	Sorghum	30.4	1,613
2	Millet	25.0	1,328
3	Cowpeas	13.2	702
4	Maize	9.6	509
5	Seed cotton	9.1	483
6	Groundnuts	7.2	385
7	Sesame seed	1.0	51
8	Rice	1.0	51
9	Bambara beans	0.8	44
10	Karite nuts	0.5	28

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

TABLE 4.4 Value of production of leading agricultural commodities in Burkina Faso, 2005–07 (millions of US$)

Rank	Crop	Percent of total	Value of production
	Total	100.0	1,214.6
1	Sorghum	23.8	289.6
2	Millet	17.0	206.7
3	Seed cotton	16.7	202.4
4	Maize	12.3	150.0
5	Cowpeas	9.6	116.0
6	Other fresh vegetables	3.6	43.4
7	Rice	3.2	39.2
8	Groundnuts	2.8	34.1
9	Sugarcane	1.8	21.7
10	Onions	1.2	14.4

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

TABLE 4.5 Consumption of leading food commodities in Burkina Faso, 2003–05 (thousands of metric tons)

Rank	Crop	Percentage of total	Food consumption
	Total	100.0	4,946
1	Sorghum	24.2	1,195
2	Millet	19.5	962
3	Fermented beverages	13.7	678
4	Maize	12.6	625
5	Rice	4.8	238
6	Other vegetables	4.1	204
7	Groundnuts	3.6	178
8	Other pulses	3.2	156
9	Beef	2.0	101
10	Wheat	1.4	69

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

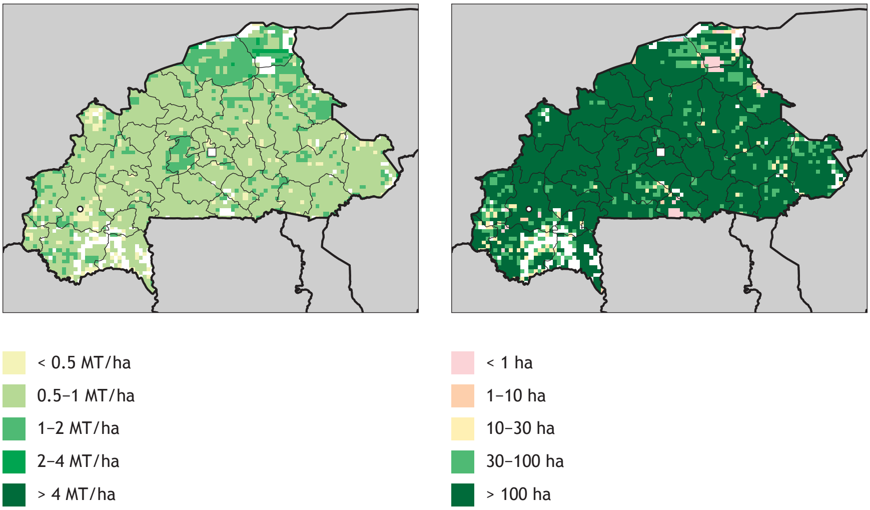
The next four figures show the estimated yields and growing areas of key crops in Burkina Faso in 2000. Sorghum (Figure 4.9) and millet (Figure 4.10) are cultivated in almost all parts of the country except the southwest; sorghum is more widely cultivated than millet. Yields of both crops range from 0.5 to 1.0 metric tons per hectare. Cotton (Figure 4.11) and maize (Figure 4.12) are mainly grown in the southwest, with maize cultivation extending to the central part of the country. Yields of both crops range from 1.0 to 2.0 metric tons per hectare.

Economic and Demographic Scenarios

Population

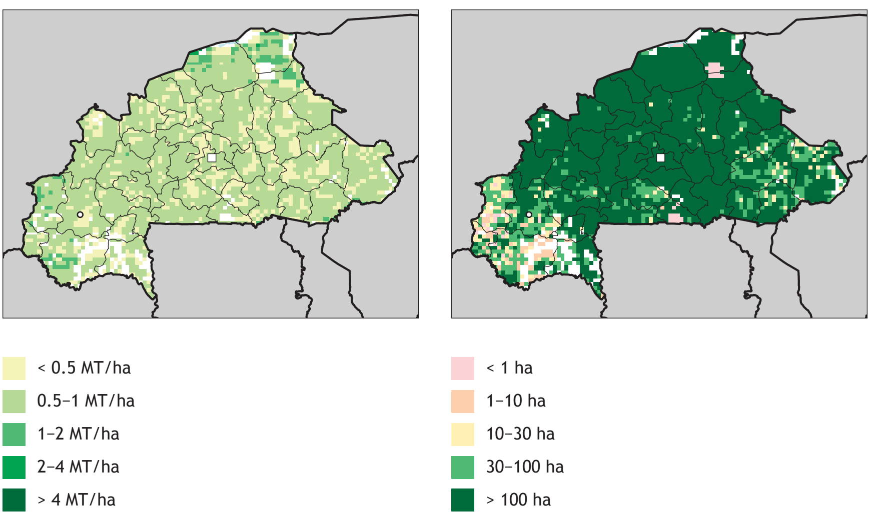
Figure 4.13 shows population projections for Burkina Faso by 2050 according to the United Nations (UN) population office. The projections of the national statistics and demography institute in Burkina Faso show the total population increasing to 21.5 million by 2020 (Burkina Faso, INSD 2009). The UN projections are in agreement, showing a total population greater than 30 million in 2050. An increasing population will impose severe pressure on the natural resource base as well as on public and social services, presenting a growing challenge for the government.

FIGURE 4.9 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed sorghum in Burkina Faso, 2000



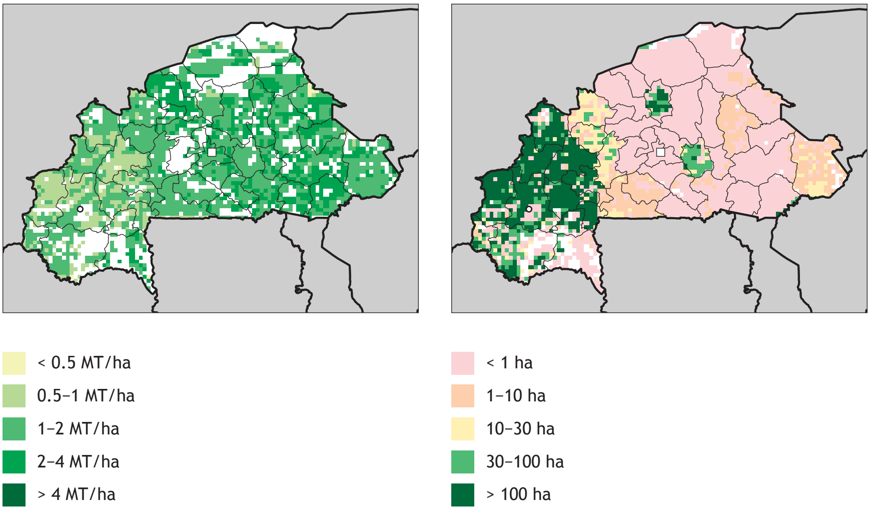
Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 4.10 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed millet in Burkina Faso, 2000



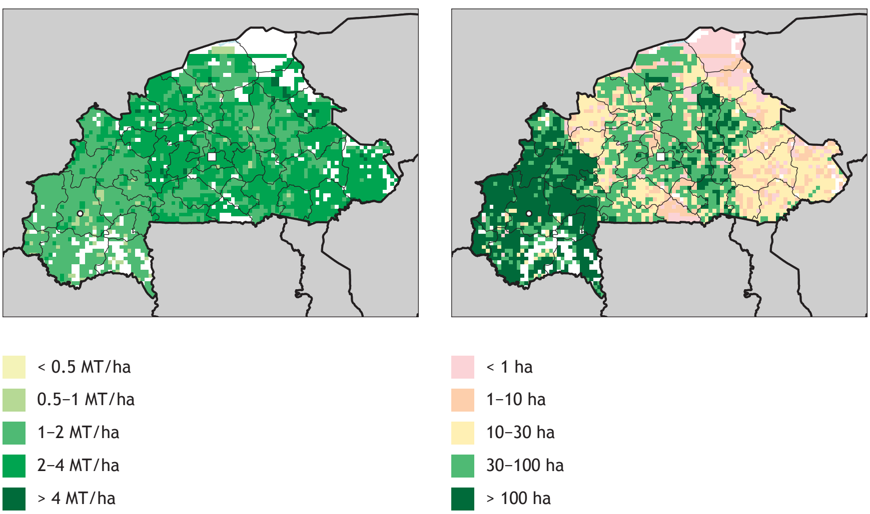
Source: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 4.11 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed cotton in Burkina Faso, 2000



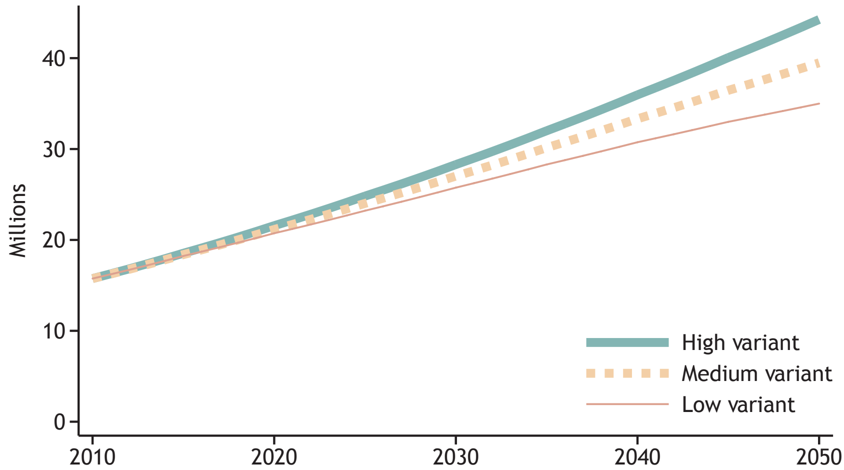
Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 4.12 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed maize in Burkina Faso, 2000



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

FIGURE 4.13 Population projections for Burkina Faso, 2010–50



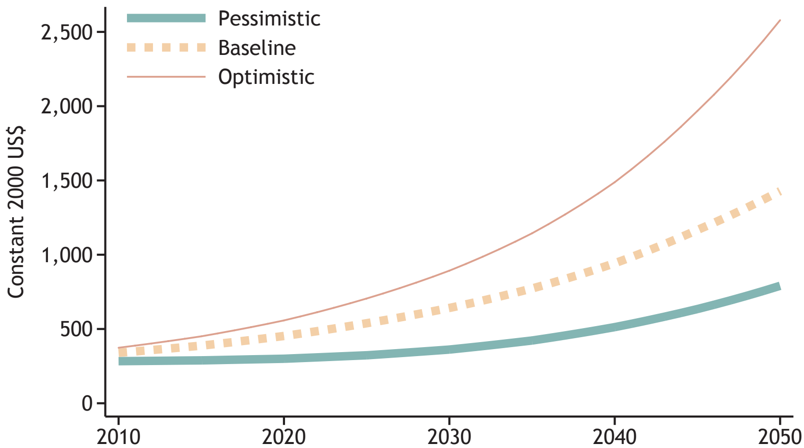
Source: UNPOP (2009).

Income

Figure 4.14 presents three scenarios for future national GDP per capita, derived by combining three GDP projections with three population projections from the UN. The optimistic scenario combines high GDP with low population; the baseline scenario combines the medium GDP projection with the medium population projection; and the pessimistic scenario combines the low GDP projection with the high population projection. (The agricultural modeling in the next section will use these scenarios as well.)

The economy of Burkina Faso depends on the agricultural sector (mainly cotton and livestock) and recently has depended on the mineral sector (mainly gold). Burkina Faso has very limited natural resources, and unless new mineral resources are discovered, it will be almost impossible to realize the optimistic scenario and the associated growth in GDP per capita. The pessimistic scenario predicts a rather small improvement in per capita GDP, which will rise above US$500 only after 2040 and still be below US$1,000 in 2050. The optimistic scenario predicts a rapid increase in per capita GDP between 2030 and 2050, from US$800 in 2030 to above US$2,500 in 2050.

FIGURE 4.14 Gross domestic product (GDP) per capita in Burkina Faso, 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

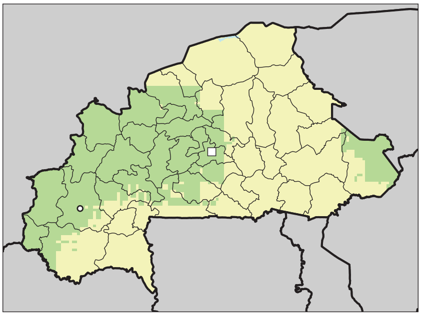
Climate Scenarios

Figure 4.15 shows precipitation changes in Burkina Faso in the four downscaled general circulation models (GCMs) using the A1B scenario.[1] CNRM-CM3 and MIROC 3.2 medium resolution show an increase in rainfall in large areas of the country, with MIROC 3.2 medium resolution predicting wetter conditions. CSIRO Mark 3 shows drier conditions (–200 to –100 millimeters of rainfall) in the central and southwestern part of the country, whereas ECHAM 5 shows a uniform –50 to 50 millimeters for the entire country.[2]

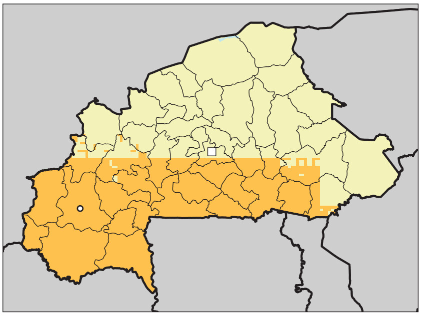
1 The A1B scenario is a greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources.

2 CNRM-CM3 is National Meteorological Research Center–Climate Model 3. MIROC 3.2 medium resolution is the Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research. CSIRO Mark 3 is a climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation. ECHAM 5 is a fifth-generation climate model developed at the Max Planck Institute for Meteorology in Hamburg.

FIGURE 4.15 Changes in mean annual precipitation in Burkina Faso, 2000–2050, A1B scenario (millimeters)

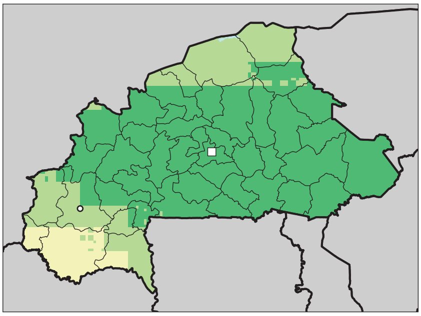


CNRM-CM3 GCM



CSIRO Mark 3 GCM

ECHAM 5 GCM



MIROC 3.2 medium-resolution GCM

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 4.16 shows the change in average daily maximum temperature in the A1B scenario according to the four GCMs. The increases in temperature range from 1.1° to 2.7°C. CNRM-CM3 and ECHAM 5 show a relatively greater increase (2.5°–3.0°C). CSIRO Mark 3 and MIROC 3.2 medium resolution show an increase of 2.0°–2.5°C and 1.0°–1.5°C, respectively. Temperature increases in the tropics generally lead to a reduction in crop yields and production. Most of the cereal crops grown in Burkina Faso can withstand temperature increases if sufficient water is available. However, taking into account the lack of irrigation possibilities, crop yields in these models would be expected to decrease unless rainfall increased enough to compensate.

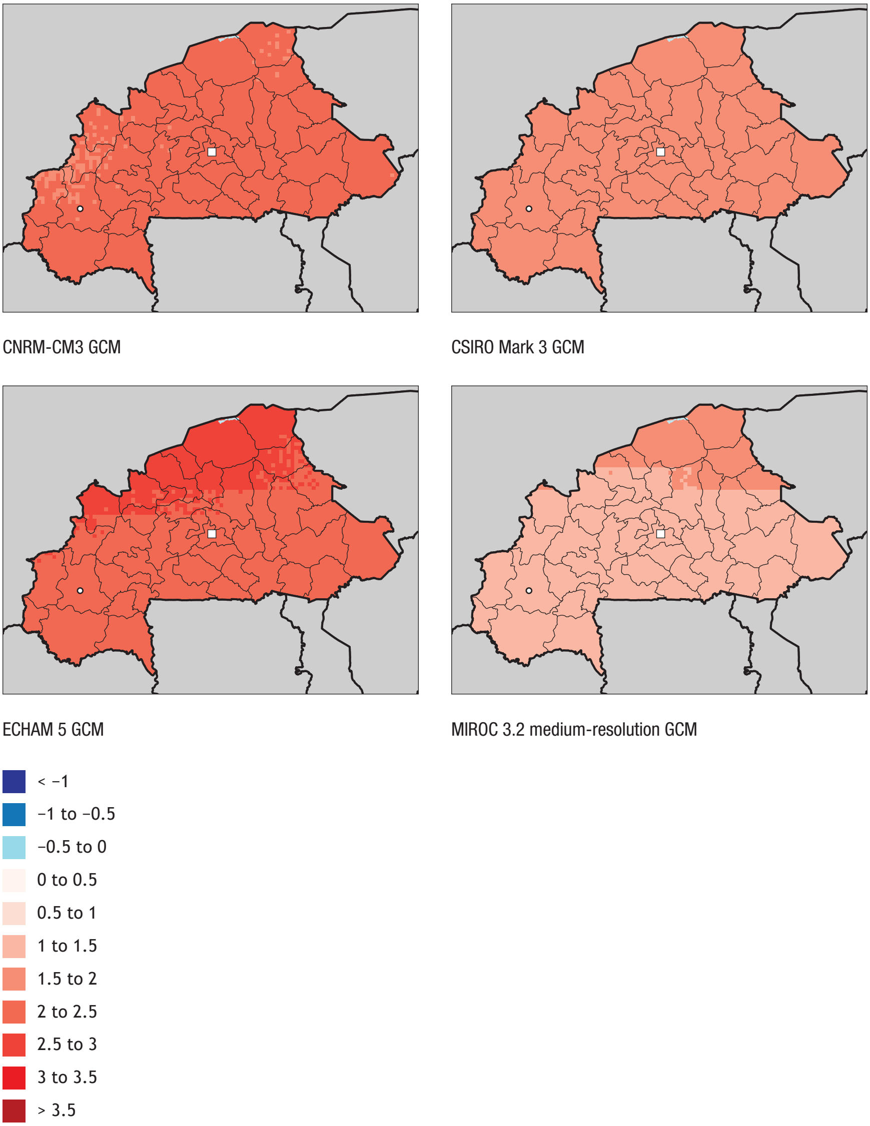
Crop Physiological Response to Climate Change

We used the Decision Support Software for Agrotechnology Transfer (DSSAT) crop model to compute crop yields in Burkina Faso in the current temperature and precipitation regimes. We then repeated the exercise for each of the four GCMs for the year 2050, with crop variety, soil, and management practices held constant for all locations. The future yield results from DSSAT were compared to the current or baseline yield results from DSSAT. The next two figures show the output for two key crops, sorghum and maize, comparing crop yields for 2050 with climate change to the crop yields assuming an unchanged (2000) climate.

Figure 4.17 shows a yield loss of 5–25 percent of baseline for sorghum according to all the models. Additionally, ECHAM 5 and MIROC 3.2 medium resolution show a yield loss greater than 25 percent in various parts of the country, particularly the central to southwestern regions. All models also indicate a loss of cropping area in the northernmost regions of the country. The loss is greatest based on ECHAM 5. However, in small areas scattered in the central region, there may also be a yield gain.

All scenarios show a significant area of the country where the maize yields will increase by 5–25 percent, with greater than 25 percent increases in some areas (Figure 4.18). However, all the models also show a reduction in the maize yields in the current maize-growing areas. The increase in maize yields in other parts of the country might be partially explained by the possible increase in rainfall in those areas during critical growth phases, or perhaps increased solar radiation will be responsible for increasing the growth rates and yields.

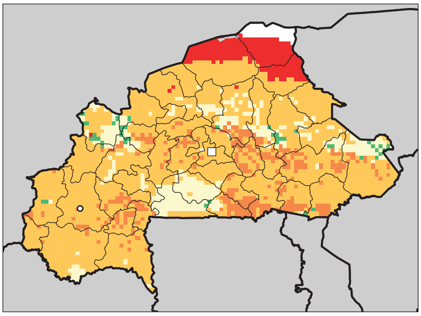
FIGURE 4.16 Change in monthly mean maximum daily temperature in Burkina Faso for the warmest month, 2000–2050, A1B scenario (°C)



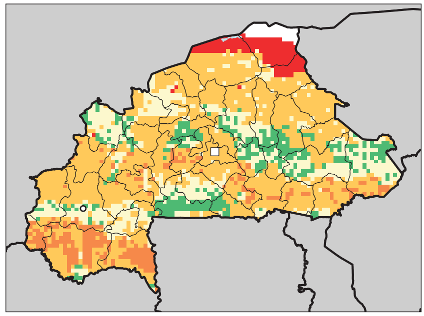
Source: Authors' calculations based on Jones, Thornton, and Heinke (2009).

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.

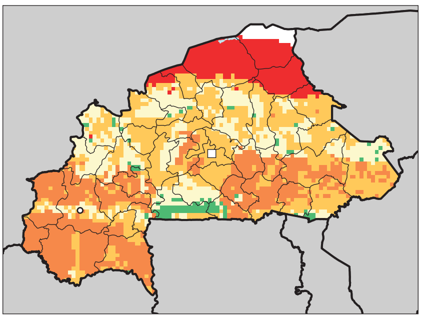
FIGURE 4.17 Yield change under climate change: Rainfed sorghum in Burkina Faso, 2000–2050, A1B scenario



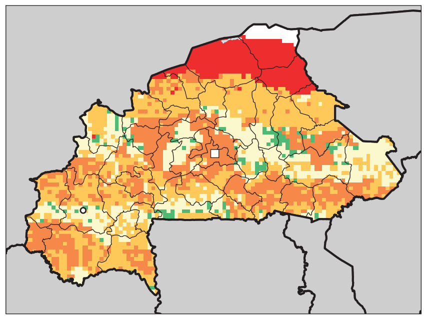
CNRM-CM3 GCM



CSIRO Mark 3 GCM



ECHAM 5 GCM



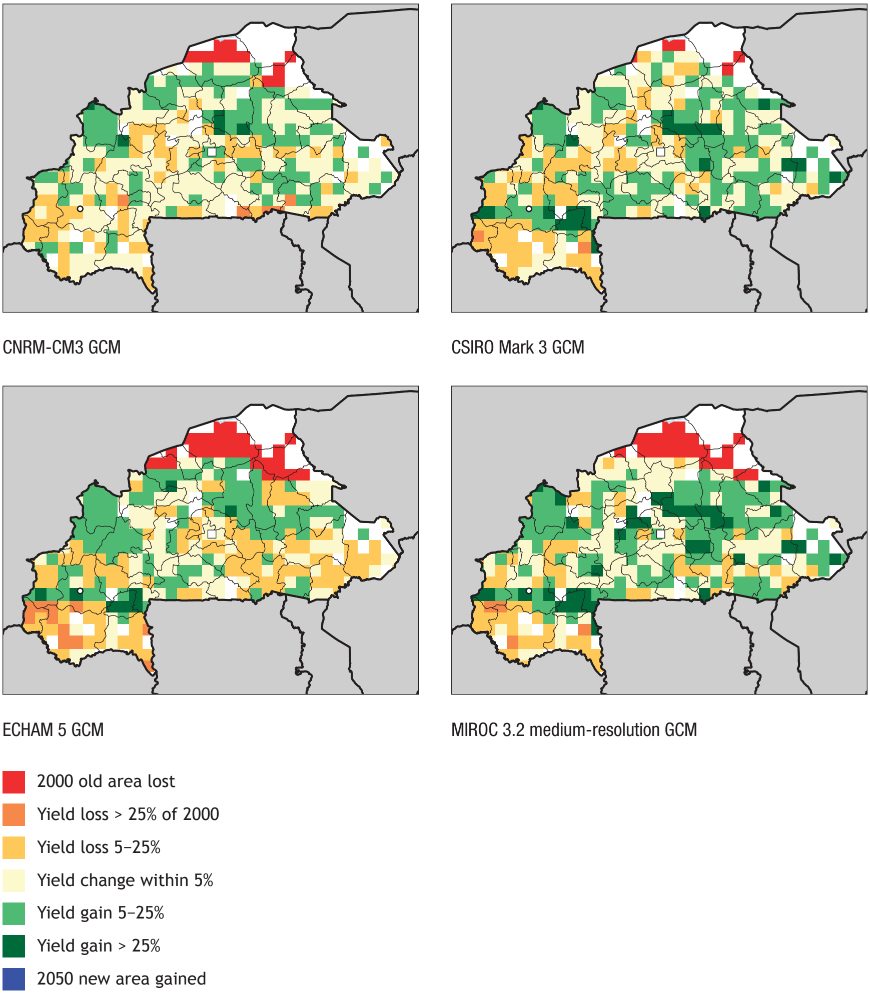
MIROC 3.2 medium-resolution GCM

- 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 4.18 Yield change under climate change: Rainfed maize in Burkina Faso, 2000–2050, 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.

Agricultural Vulnerability Scenarios (Crop-Specific)

The next four figures show simulation results from IMPACT associated with key agricultural crops in Burkina Faso. The figure for each featured crop has five graphs showing production, yield, area, net exports, and world price. Sorghum production—based on area cultivated as well as productivity per unit area—increases in all of the scenarios (Figure 4.19). This increase will primarily be led by increases in sorghum yield but will also be due to increases in sorghum area planted. The improvement in sorghum crop yield can perhaps be attributed to the anticipated selection and breeding effort of the agricultural research service and to the use of adaptive technologies by farmers. Net exports of sorghum increase after 2035 in both the optimistic and the baseline scenarios but to decrease in the pessimistic scenario. The increase in exports due to rising production is plausible with an increase in trade in the subregion.

Similar to the case of sorghum, the area under production and the yield for millet are shown to increase in all the scenarios (Figure 4.20). The millet yield, like that of sorghum, can be further improved by the selection and breeding efforts of the agricultural research service and by the use of adaptive technologies by farmers. However, unlike in the case of sorghum, all the scenarios show an increase in the net export of millet between 2040 and 2050.

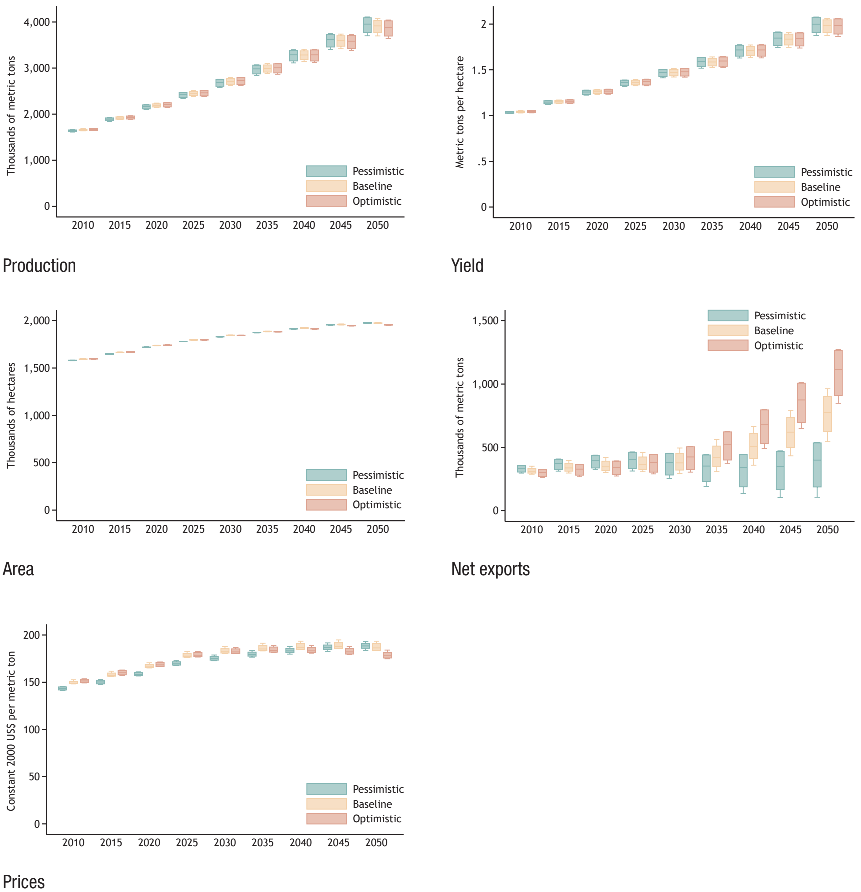
Trends for cotton are similar in all the scenarios and are also similar to those for millet. Recently Burkina Faso adopted highly productive genetically modified cotton, supporting the plausibility of the production and yield trends shown in Figure 4.21.

The trends for maize production—in area of production, yield, net exports, and world price—are also similar in all the scenarios (Figure 4.22). Although maize production is shown to increase due to increased productivity, the area planted with the crop will decline slightly. The increase in productivity will be due to improved management practices as well as technological improvements. Maize varieties are currently available in Burkina Faso that yield much more than the yield projected for 2050. Maize consumption in urban areas has risen in the past five years; with the projected increase in population, domestic demand for maize should continue to increase. The increase in local demand will mean a decrease in net exports, despite an increase in the world price of maize.

Human Vulnerability Scenarios

Figure 4.23 shows the impact of future GDP and population scenarios on under-five malnutrition rates in Burkina Faso. The box-and-whisker plots

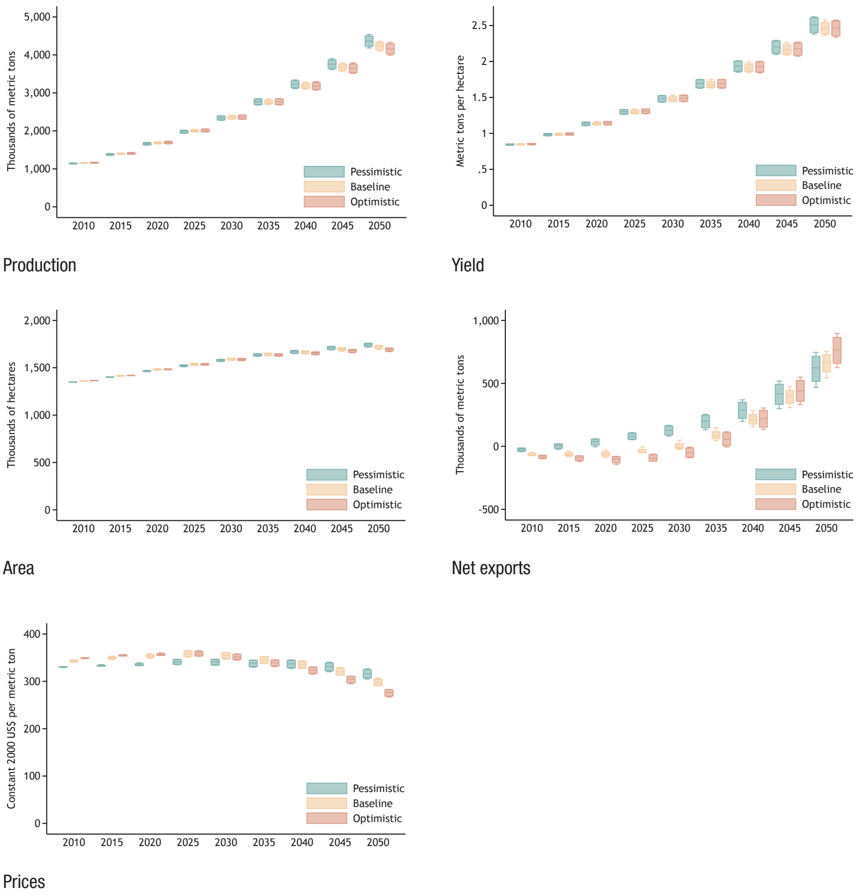
FIGURE 4.19 Impact of changes in GDP and population on sorghum in Burkina Faso, 2010–50



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.

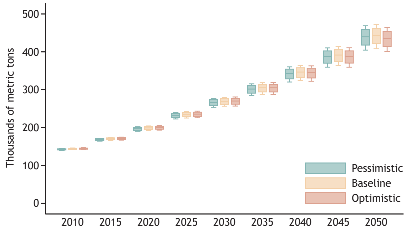
FIGURE 4.20 Impact of changes in GDP and population on millet in Burkina Faso, 2010–50



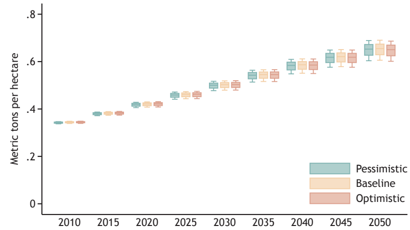
Source: Based on analysis conducted for Nelson et al. (2010).

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.

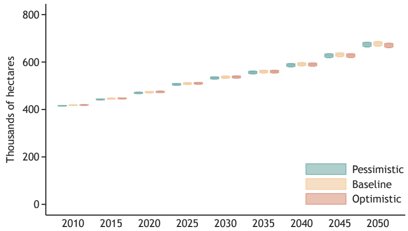
FIGURE 4.21 Impact of changes in GDP and population on cotton in Burkina Faso, 2010–50



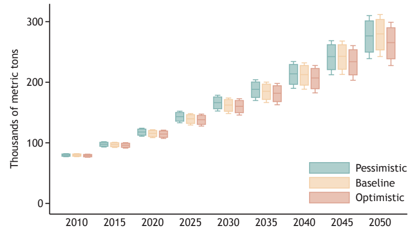
Production



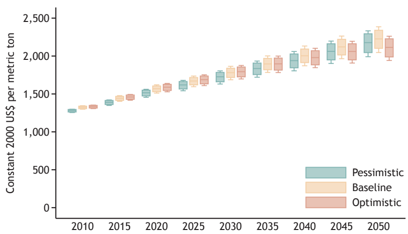
Yield



Area



Net exports

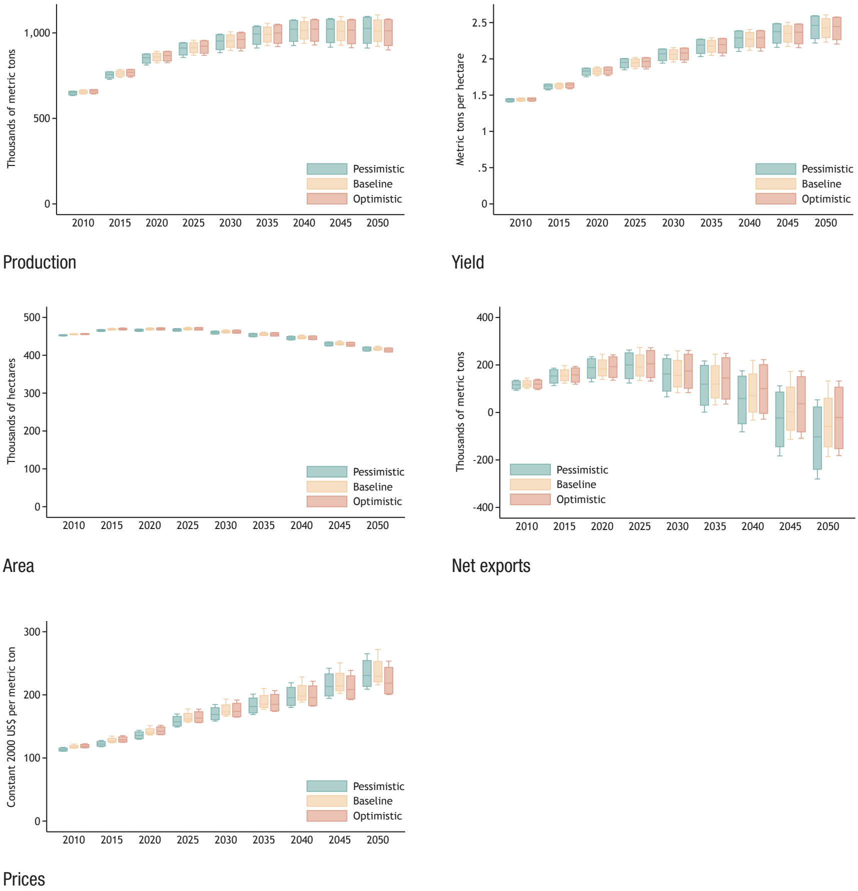


Prices

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 4.22 Impact of changes in GDP and population on maize in Burkina Faso, 2010–50



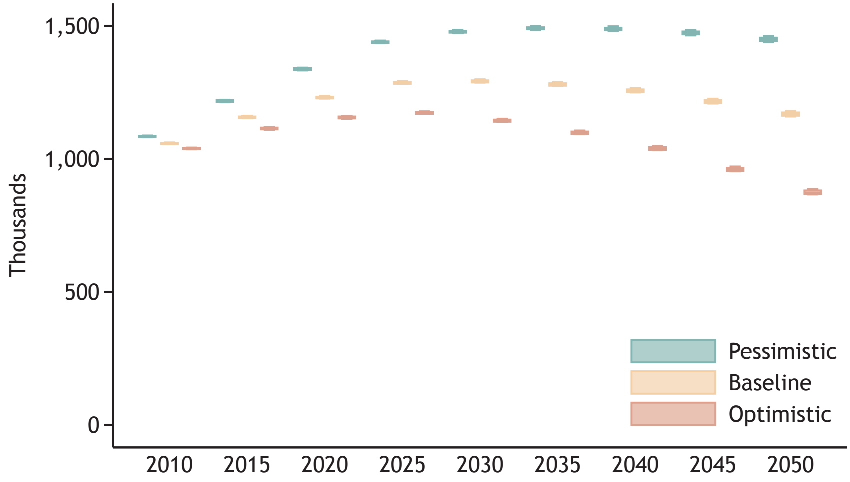
Source: Based on analysis conducted for Nelson et al. (2010).

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 the figure indicate the range of climate scenario effects. All scenarios show an increase in the number of malnourished children under age five in the near future, at least until 2025. Only the optimistic scenario has a lower number in 2050 than at present. Although the number of malnourished children increases in the baseline and pessimistic scenarios, it is likely that the *proportion* of children who are malnourished will decline in all scenarios, because the population is projected to increase at a larger rate than the number of malnourished children is projected to increase.

Figure 4.24 shows the available kilocalories per capita. The pessimistic scenario shows only a small increase by 2050, with a declining trend in calories until 2025. The other scenarios, however, paint a much brighter future. The optimistic scenario shows the largest increase, perhaps explaining the decline in the number of malnourished children shown in Figure 4.23.

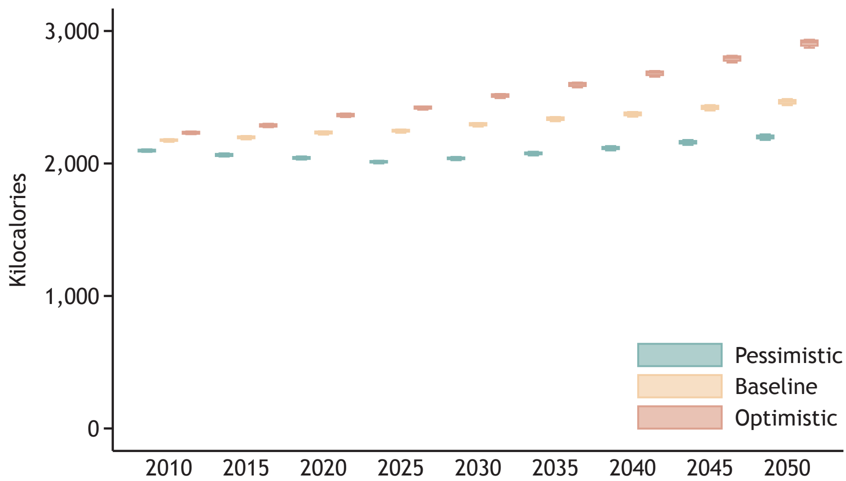
FIGURE 4.23 Number of malnourished children under five years of age in Burkina Faso in multiple income and climate scenarios, 2010–50



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 4.24 Kilocalories per capita in Burkina Faso 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.

Conclusions and Policy Recommendations

This chapter outlines Burkina Faso's current vulnerability to climate change with respect to land use and agriculture and analyzes the potential impact of climate change on crop production. The results of the study on which the chapter is based confirm the high level of uncertainty in rainfall for Burkina Faso indicated by the Intergovernmental Panel for Climate Change (Parry et al. 2007) for all of West Africa. The study results also highlight the challenges Burkina Faso faces regarding the availability of data for climate change analysis. The lack of data for forecasting models creates a handicap for long-term forecasting efforts and thus for the efficient use of scenarios. There is thus an urgent need to support the meteorological and hydrological services.

Our analysis also points to the following policy implications:

- Support is needed for the agricultural research system to continue its efforts in developing crop varieties tolerant of or resistant to changing climatic conditions of temperature and rainfall.

- Capacity building is needed for all stakeholders—particularly farmers—to enable them to adequately manage crops so that optimum productivity levels can be achieved in view of the challenges of climate change.
- Control (mobilization and distribution) of surface water and groundwater is essential for the supply of water, not only to populations and animals but also to crops. Irrigation during dry spells in the rainy season and full irrigation in the dry season are needed in order to improve the food security of the country.
- Permanent availability of water and other inputs, such as fertilizers and pesticides, will ensure the development of garden market crops. High priority must be granted to this activity, because it appears to present one of the best opportunities for women and young people to improve their incomes.
- It will be helpful to promote the widespread adoption and use of appropriate and proven field water harvesting technologies, such as *zai,* combined with stony lines, half- moons, mulching, and the like.[3] These techniques are also designed to control the runoff and erosion phenomenon which contributes largely to land degradation.

Our study should improve the level of understanding of climate change issues for all the stakeholders, in particular for decisionmakers engaged in planning to meet the UN's Millennium Development Goals.

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3 The traditional method for constructing zai consists of digging tiny pits 10 centimeters in diameter and 5 centimeters deep with hoes to break the surface crust during the dry season. The Harmattan wind transports sand and organic materials into the pits. Improved technology involves digging larger pits, 20–50 centimeters in diameter and 10–25 centimeters deep, to store more rainfall and runoff. Animal manure added after the first rains complements the work of the wind and makes nutrients more available to crops (Reij and Toulmin 1996). Half-moons are a technology applied on the Arenosols of the Sahelian zone and on the ferruginous soils in the savannah. It consists of the construction of semicircular structures 15–20 centimeters deep, with the remaining soil arranged as a contour bund on the curved side with a diameter of 3–4 meters.

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