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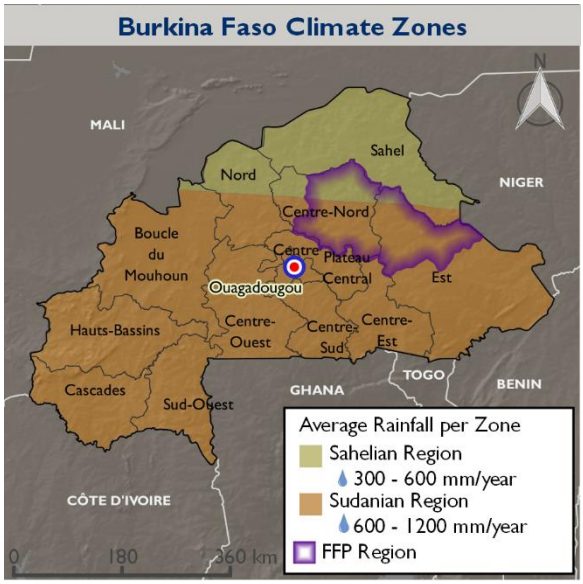
Climate Risk Profile

CLIMATE RISKS IN FOOD FOR PEACE GEOGRAPHIES

BURKINA FASO

COUNTRY OVERVIEW



Northern Burkina Faso, the focus of USAID's Food for Peace (FFP) in-country programming, is a semi-arid region that is chronically food insecure. In this area, poverty, limited rainfall, high evaporation rates, dependence on rainfed crops, and poor soils make people highly vulnerable to climate shocks (such as droughts, floods, heat waves and dust storms) that drive down agricultural production and increase food prices. Trends toward increasing temperatures, rising evaporation rates and heavy rainfall events may exacerbate these hazards, adversely impacting food security, health and water resources. Weather trends that negatively impact resource availability also threaten to intensify tensions over limited land and water resources and accelerate rural to urban and north to south migration. Burkina Faso has a high population growth rate (3 percent per year during 2010–2015), pervasive poverty (43.7 percent live on less than $1.90 per day), a highly rural population (70 percent) and a heavy reliance on agriculture, which employs more than 80 percent of the working population and accounts for about 34 percent of GDP. These factors are driving expanded cultivation and extensive, low-input agricultural production, both of which increase pressure on natural resources essential to the country's mostly rural population. (6, 26, 27, 31, 47, 48)

CLIMATE PROJECTIONS

- 1.6°– 2.8°C increase in temperatures by 2050
- Increased frequency and intensity of heavy rainfall
- Increased heat waves, longer dry periods

KEY CLIMATE IMPACTS

Agriculture and Livelihoods

Crop loss/failure and reduced crop and livestock productivity
Increased water scarcity and land degradation
Increase in pest/disease outbreaks
Increased conflict over natural resources

Health, Nutrition and WASH

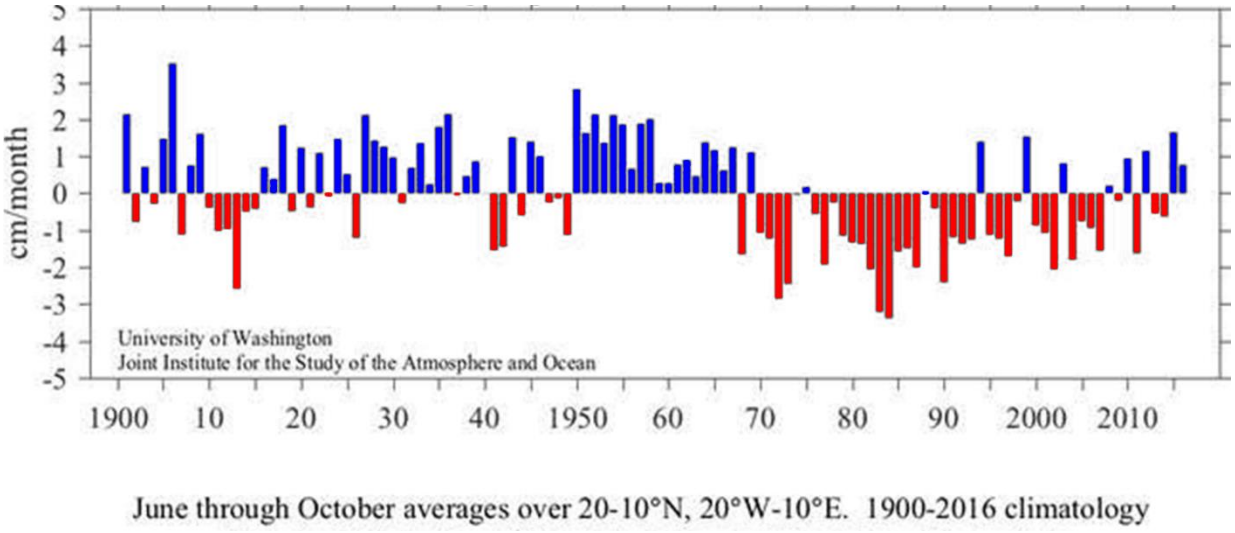
Reduced water availability/quality
Heat stress
Increased flood-related mortality/morbidity
Increased food insecurity
Increased vector- and waterborne diseases

August 2017
This document was prepared under the Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) Task Order No. AID-OAA-I-14-00013 and is meant to provide a brief overview of climate risk issues. The key resources at the end of the document provide more in-depth country and sectoral analysis. The contents of this report do not necessarily reflect the views of USAID.

CLIMATE SUMMARY

Northern Burkina Faso is dominated by a semi-arid climate that receives 400–900 mm of rainfall annually, distributed over 50–70 rainy days. Rainfall totals, however, show high interannual and decadal variability as well as spatial variability. The high level of variability (Figure 1), unrelated to broader climate trends, makes detection and projection of longer-term precipitation trends difficult. The region experienced the worst drought of the 20th century in the 1970s and 1980s, marked by a 40 percent decrease in long-term average rainfall in the early 1980s. Although some recovery occurred in recent decades, cumulative rainfall in this part of the Sahel has not returned to pre-1960s levels.

Figure 1: Annual rainfall variability compared to average in the Sahel (1900–2016)[1]



Source: University of Washington Joint Institute for the Study of the Atmosphere and Ocean.

Burkina Faso has pronounced wet and dry seasons. A two-month wet season in the far north (beginning in June or July) gradually shifts to a longer six-month wet season to the south (May–October). Rainfall peaks in August. The dry season (December–March) brings dust-laden Harmattan trade winds from the northeast that reduce humidity and can produce severe dust and sand storms.

Annual average temperatures range between 27°–30°C and some seasonal temperature variation does occur, namely in the north, where temperatures can range from 15°–45°C throughout the year. The hottest months, May and June, come at the onset of the wet season, while the coldest months, December and January, come at the onset of the dry season. The average heatwave[2] duration is six days. (4, 5, 12, 14, 21, 29, 38, 46)

[1] Data based on all weather stations in the Sahel with data sets of 10 years or longer including the qualifying Sahel station in Burkina Faso, Dori (just north of the FFP program area).

[2] Days above the 95th percentile for average temperature.

Table 1: Climate trends and projections		
Parameter	**Observed trends**	**Projected changes (2050)**
Temperature 	• Increased average annual temperatures by 0.10°C per decade from 1901–2013, with stronger warming of 0.26°C per decade over the last 30 years • Increased average monthly temperatures, more pronounced in June, July and August	• Increased average temperatures by 1.6°–2.8°C • Increased hot days and hot nights • Increased duration of heatwaves by 8–26 days • Decreased duration of cold spells by 4–8 days
Rainfall 	• A dry period from the late 1960s to early 2000s, following a comparatively wetter period in the roughly 50 years before 1968 • Extension of arid zone to the south	• Uncertain precipitation projections due to high interannual/decadal variability, but a projected change in annual precipitation of -3 to +11 percent by 2050 • A tendency for precipitation to increase in the second half of the wet season (August–October) with no change during the first half (June–July) and greater increases in the east • Likely decrease in dry spells, with a range of -9 to +5 days • Increased heavy rainfall intensity (1–19 percent) and frequency (6–42 percent) • Change in annual actual evaporation, with a range of -3 to +14 percent • Changes in drought occurrence remain highly uncertain – some models suggest a decrease in dry spells and others suggest increased interannual variability

Defining Drought

Drought is generally defined as an extended period – a season, a year or several years – of deficient precipitation compared to the statistical multi-year average for a region that results in water shortage for some activity, group or environmental sector. However, dozens of more specific drought definitions are used around the world, based on the lack of rain over various time periods, or measured impacts such as reservoir levels or crop losses. In this risk profile, the term "drought" is used according to meteorological criteria (as opposed to agricultural, hydrological or socioeconomic). Meteorological drought occurs when precipitation departs from the long-term normal. ***Source: FAO***

CURRENT FFP INVESTMENTS IN BURKINA FASO

USAID FFP programs in Burkina Faso target food-insecure Burkinabe nationals and Malian refugees. Programming is focused in the northern half of the country (northern parts of East and North-Central Regions). The FFP non-emergency program's focus is to reduce food insecurity among vulnerable rural populations. Mission objectives are to:

- Reduce chronic malnutrition among children under five years and pregnant and lactating mothers, with a focus on the first 1000 days
- Increase and diversify household incomes
- Strengthen and diversify agricultural production and productivity

FFP and partners implement core interventions in agriculture and natural resources management, health and nutrition, and civil society strengthening. Programs focus on improving the nutritional

status of the most vulnerable populations, agricultural production and productivity, and livelihood diversification and promotion of the use of good governance practices within community-based organizations. Activities include targeted food distributions, food-for-work initiatives, school feedings, take-home rations, and training on nutrition, hygiene and sanitation best practices. Additionally, FFP supports efforts to respond to acute malnutrition and to strengthen the resilience of vulnerable and food-insecure populations. FFP collaborates with the USAID Resilience in the Sahel Enhanced (RISE) initiative in the implementation of Development Food Assistance Programs (DFAPs) and Resilience and Economic Growth in the Sahel (REGIS) programs.

BURKINA FASO FFP PROGRAM AREA LIVELIHOOD ZONES

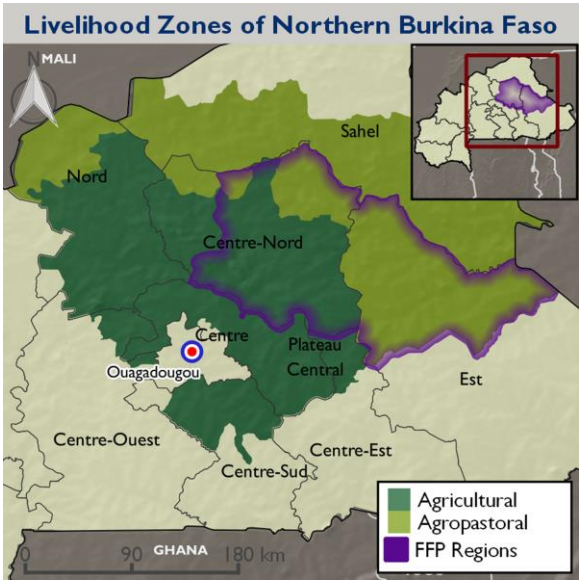
The FFP program area, located in East and North-Central Regions of Burkina Faso, contains two livelihood zones (Figure 2). In average years, harvests do not meet food requirements, and the northernmost areas of the agropastoral and agricultural zones are some of the most food insecure in the country in terms of food availability and use. Extensive land degradation across the country impacts crop and pasture land productivity. In recent years, however, a "greening" trend has been emerging, likely associated with considerable local restoration efforts and rainfall increases.

Agropastoral — This zone forms an east-west band across the central north of the country, directly south of the pastoral zone. Rainfall ranges from 400–500 mm per year in the west to 500–700 mm per year in the east. Although local variation exists, typical farmers grow rainfed millet and sorghum intercropped with cowpea (*niébé)*; however, this practice is less common now due to the use of improved production techniques[3] promoted by the DFAPs. Groundnuts are grown mostly by women, while both women and men are engaged in growing sesame. Rice is grown in *bas-fonds (improved lowlands)*, small depressions that retain moisture after the wet season. The DFAPs have improved more than 800 hectares of *bas-fonds* for rice cultivation and gardening during the dry season. For many households, livestock (cattle, goats, and sheep in wealthier households and poultry in poorer ones) are the principle source of savings and investment and an important source of cash. There is high dependence on markets for staple grains. The northern and western areas of this zone are drier, with less reliable rainfall and more food insecurity. In very good years, the zone produces surpluses and sells to neighboring regions. Water shortages are a chronic hazard and limit FFP's efforts in promoting good practices in WASH.

[3] Improved techniques include: intercropping techniques, using cowpea with sorghum or millet; using mulch to hold moisture, reduce soil erosion and reduce cultivation demands; conducting variety demonstrations for cowpea, sesame, sweet potatoes and lowland rice; producing cowpea for forage as well as grain; comparing improved and local varieties; comparing different types of organic fertilizer, including grass, manure and improved compost; using a simple, low-cost design for a water control structure in mildly sloping lowlands to contain rainwater for rice production; implementing water and soil conservation techniques (stone barriers, zaï, half-moons); storing cowpea in triple-layer (PICS) bags; and using hay mowing and storage techniques to conserve nutritional value.

Agricultural — With more reliable and slightly higher rainfall (600–700 mm per year), this zone produces rainfed sorghum, millet, rice and cowpea for household consumption. Market gardening of vegetables, onions and tomatoes is relatively well-developed. In general, crop yields are limited by degraded soils, small plots and high population density. Livestock are less prominent than in the other livelihood zones, but small ruminants and poultry remain important income sources. Poultry disease is a chronic hazard and poor or irregular rainfall is a hazard three years out of ten. (33, 42, 43)

Figure 2: Livelihood zones of northern Burkina Faso

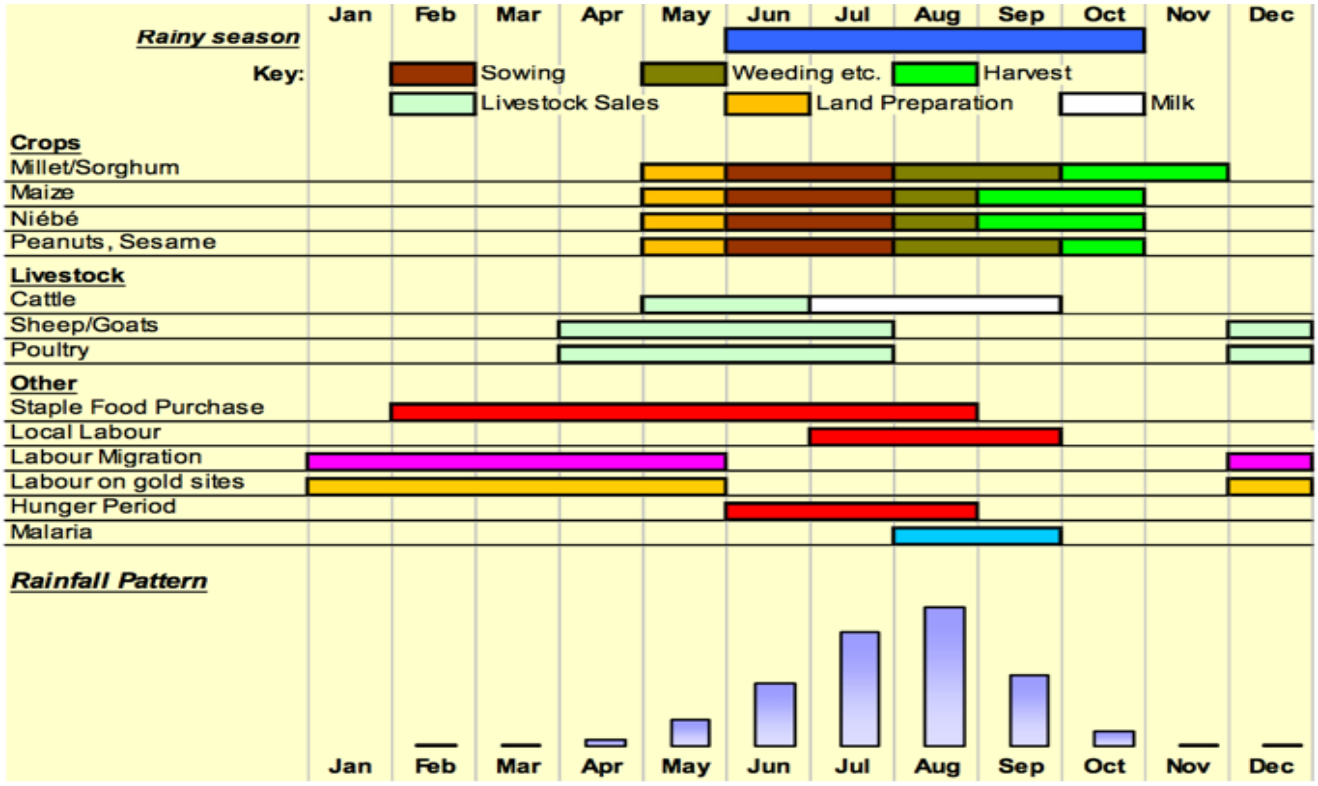


Source: USAID FEWS NET 2010

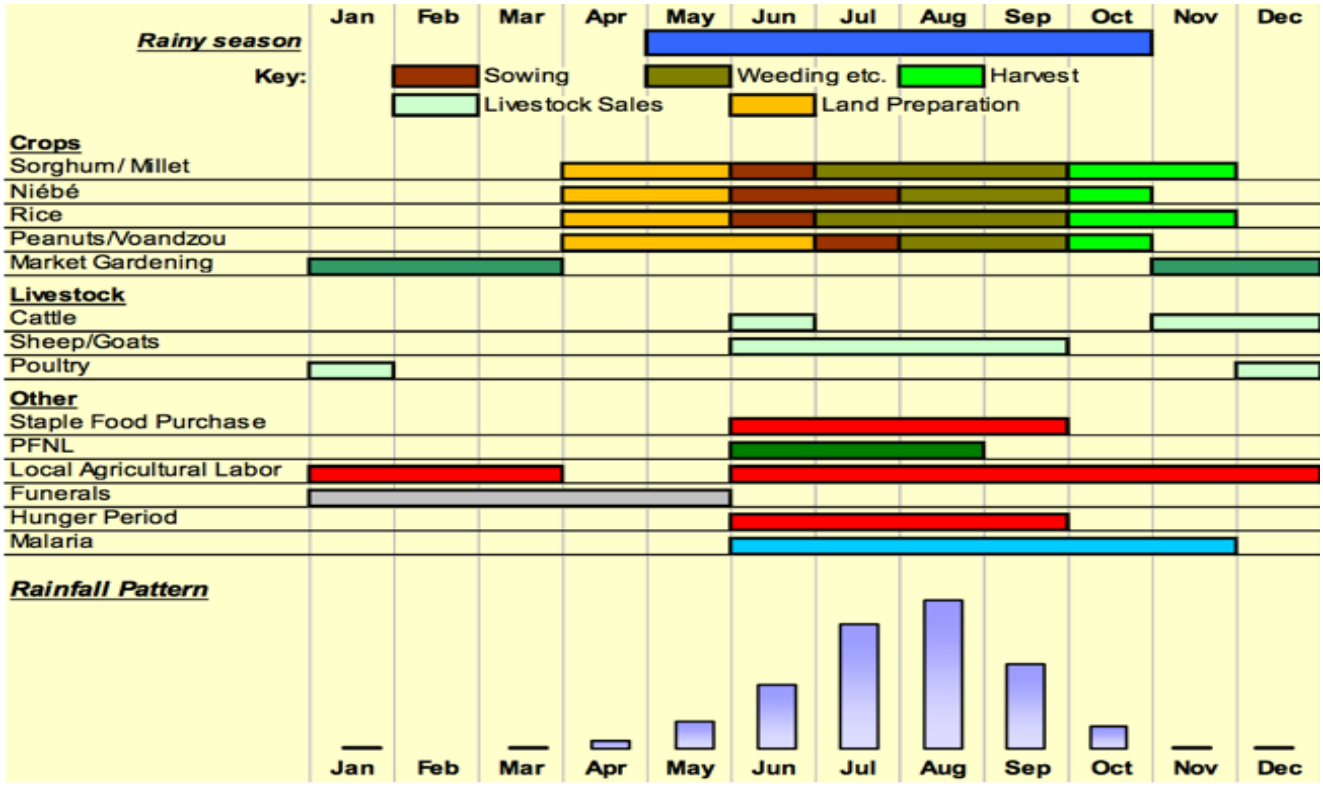
Figure 3 illustrates typical agropastoral and agricultural seasonal calendars for the FFP livelihood zones in the country. The agropastoral calendar includes milk production, labor migration and a longer period of staple food purchase. In contrast, the agricultural calendar includes market gardening, earlier land preparation, a period of accessing forest products and wild foods (PFNL), and a slightly longer hunger period.

Figure 3: Typical (a) agropastoral and (b) agricultural seasonal calendars in Burkina Faso

a) Agropastoral seasonal calendar



b) Agricultural seasonal calendar



Source: USAID FEWS NET 2010

SECTOR IMPACTS AND VULNERABILITIES

CROP PRODUCTION

Crop production in northern Burkina Faso is highly vulnerable to climate variability and change since production is predominantly rainfed and limited by a short, wet season. Crop production is mainly subsistence and dominated by smallholders working plots averaging just a few hectares. In normal years, farmers' harvests do not cover their food requirements, but in very good years, some farmers are able to produce cereal surpluses. Poor and very poor farmers in particular rely on food purchases, gifts and payment-in-kind to meet food needs. Climate stressors that could negatively impact productivity in the FFP zones include increasing temperatures, heatwave duration, evaporation, heavy rainfall and dry periods. Climate crop models project declines in yields of 15–25 percent across the Sahel by 2080 due to increased temperatures, heatwaves and heavy rainfall, including for staples like millet and sorghum. In addition to evolving climate factors, current challenges such as lack of access to inputs and credit, low utilization of improved agricultural management techniques and lack of arable land may continue to constrain productivity.

Commonly grown crops in FFP program areas (sorghum, millet and cowpea) exhibit both sensitivities and adaptive characteristics related to projected climate trends. Rising temperatures and heatwaves directly impact crop yields and increase certain pest and disease risks; sorghum in particular shows reduced yields at temperatures over 35°C. Additionally, the region's nutrient-poor, sandy and shallow soils are highly vulnerable to drying and wind and water erosion, which would be exacerbated by heavy rainfall and associated flooding. While the region's crop production is

sensitive to climate, the common use of local seed varieties (more than 90 percent of seeds are local varieties saved year to year or sourced through informal systems) means much of the ongoing crop production is adapted to the existing highly variable climate conditions. However, as variability increases, local varieties' ability to adapt may not keep pace. Of the three crops, millet is the most reliable grain in hot, drought-prone areas with sandy soils, and is the only rainfed grain planted in areas receiving less than 400 mm of rainfall. With the promotion of soil and water conservation techniques since the 1980s (and more recently by the DFAPs), sorghum is also a viable option in many areas. Millet and sorghum are frequently intercropped on family farms as a way to hedge against uncertain rainfall. In such cases, the goal of the farm household is not to maximize returns, but rather to ensure sufficient production in the face of uncertain rainfall.

Table 2 demonstrates common crop climate sensitivities and adaptive characteristics, including sensitivities related to changes in pest and disease dynamics under the possibly drier or wetter conditions resulting from the uncertain future of the area's rainfall.

Table 2: Adaptive characteristics and climate sensitivities of key crops

Crop	Climate sensitivities	Adaptive characteristics
Millet	• Cannot tolerate waterlogging or immersion • Requires evenly distributed rainfall during growth period; does not go into dormancy during drought like sorghum • Excess rain during flowering can cause crop failure • Hot, dry conditions increase risk of witchweed infection and damage; hot, wet conditions increase risk of downy mildew	• Most reliable grain in hot, drought-prone areas with sandy soils • Tolerant of temperatures up to 46°C (42°C at flowering) • Only rainfed grain productive in areas with less than 400 mm of rainfall
Sorghum	• Sensitive to moisture stress during grain-filling stage, when dry periods of two weeks or more significantly diminish yields • Poor performance if rainfall is less than 450 mm • Temperatures above 35°C can reduce yields • Hot, dry conditions increase risk of damage from khapra beetle and Striga purple witchweed; hot, wet conditions increase risk of sorghum midge, anthracnose, sorghum downy mildew and zonate leaf spot	• Drought-tolerant; goes dormant during water stress and resumes growth when conditions improve • Tolerates waterlogging of up to two weeks • Does well on most soils; moderately tolerant to soil salinity
Cowpea	• Average temperatures over 33°–35°C can negatively impact flower development, leading to reduced yields • Sensitive to dry periods longer than 3–5 days during flowering • Warm, moist conditions can delay maturity • Hot, dry conditions increase risk of damage from cowpea aphids, cowpea aphid-borne mosaic virus (CABMV) and root-rot nematodes • Hot, wet conditions increase risk of legume pod borer, cowpea caterpillar, cercospora leaf spot and scab	• Tolerant of low rainfall; performs well with 400–700 mm of rain per year but produces with 300 mm or less • Fast-maturing • Performs best on sandy soils but performs well on a wide variety of soil types and conditions • Some varieties are photo-period sensitive • Tolerates waterlogging of up to 5 days during vegetative growth • Tolerates dry periods of up to 15 days during emergence and grain-filling stages

While 21st century droughts have not been as severe as those seen in the 1970s and 1980s, they continue to be the main concern for farmers. Climate projections for potentially longer and/or drier periods pose a significant risk. With poor soil water retention and low rainfall, some argue that northern Burkina Faso has experienced "quasi-drought" conditions for decades, with more acute

recent droughts in 2004, 2010 and 2011–2012. Farmers surveyed in Burkina Faso's Sahel region cited drought as the number one constraint to crop production, followed by soil fertility, plant diseases and desertification. Nearly half of participants in a 2013 survey noted 100 percent loss of crop income in severe drought years while the remaining respondents said they experienced losses of 25–75 percent. In 2011–2012, insufficient rains and an early cessation of the wet season translated into 14 percent harvest reductions in northern Burkina Faso. Nearly half of the country (146 communes) reported crop failures, affecting more than 2.8 million people.

Drought combined with land use activities, such as clearing for agriculture and deforestation for fuelwood, contribute to the soil infertility and desertification that concern farmers. Between 1975 and 2013, savannas (Sahelian and Sudanian) shrank by 39 percent. While land use change and expanding cultivation over the past few decades are mainly a result of population growth, in many places drought and erosion (and resulting low soil fertility) also drove people to expand cultivation into new lands. The outcome of this negative cycle of climate factors, land use and degradation is continued livelihood vulnerability for much of the rural population, a situation that may be exacerbated by increased temperatures and more variable rainfall. (3)

Despite extensive degradation, a "greening" trend is currently underway in the Sahel (enhanced vegetation across the region). Although poorly understood, it is assumed to be associated with both the increasing rainfall levels since the 2000s and extensive local restoration efforts. Local efforts in response to drought and land degradation have rehabilitated thousands of hectares through soil and water conservation initiatives. This work appears to now be paying off through increased vegetation. (5, 7, 8, 9, 13, 22, 24, 28, 30, 32, 34, 35, 37, 38, 40, 41, 47, 48)

Table 3: CROP PRODUCTION – Climate stressors and risks

Climate stressors	Climate risks
Increased temperatures **Increased duration of heat waves**	Reduced soil moisture and increased erosion
Increased evaporation rates **Increased frequency and intensity of heavy rainfall**	Crop failure and reduced yields due to climate variability (i.e., heat stress, drought, low rainfall, heavy precipitation); increased food prices
Increased length or intensity of dry periods	Increased incidence of pests and diseases

LIVESTOCK

Livestock are typically more resilient to climate variability and shocks than crops although still susceptible to climate trends. Mobility in the pursuit of forage/pasture and water is key to the sector's resilience. In this region, where forage varies greatly both temporally and spatially, more than 85 percent of livestock owners use mobile practices. Agricultural expansion, increased competition for land and water, and changes in land management policy, however, are increasingly limiting pastoral mobility even as climate trends make this practice more necessary for successful livestock production. Climate stressors of increased temperatures, heavy rainfall and dry periods will likely increase heat stress, change pest and disease dynamics, and negatively impact rangeland productivity, feed production and water sources. Livestock are an integral part of

livelihoods across the two livelihood zones, and are a key source of food security, employment, investment, credit and savings. Livestock represent about a quarter of agriculture's contribution to GDP and more than 80 percent of the population countrywide is involved in raising livestock to some degree. Livestock production is mainly through traditional low-input systems and vaccination is rare.

While livestock numbers have grown in recent years, losses during prolonged droughts are a critical risk in FFP program areas. Livestock owners in the north ranked drought as the number one constraint to livestock production, followed by pasture scarcity, scarcity of water for livestock, and livestock disease. The poor rains of 2011–2012, for example, led to lack of forage, fodder and water for livestock in the north. Research findings from the Sahel region of Burkina Faso show that, on average, 12 percent of surveyed individuals lose all their livestock income in drought years. Another 38 percent of those surveyed lose 75 percent and 50 percent lose 25–50 percent. Climate-stressed agricultural production systems also threaten to exacerbate the longstanding and ongoing conflicts among farmers and mobile pastoralists over land and water resources. Countrywide, the Ministry of Animal Resources estimates that 4,000 farmer–herder conflicts occurred from 2005 to 2011.

The impacts of heat stress on livestock in Burkina Faso are not well-researched. However, evidence from elsewhere in Sub-Saharan Africa demonstrates that hot temperatures can reduce feed intake, reproduction and growth rates, longevity, milk production, egg laying and disease resistance. Chickens are particularly sensitive to heat waves, which can cause extensive mortality. In addition to heat stress, rising temperatures are likely to impact the range, transmission rate and outbreaks of certain livestock diseases (Box 1).

Box 1: Risks to livestock under two climate scenarios
Source: USAID. 2014. Agricultural Adaptation to Climate Change in the Sahel: Expected Impacts on Pests and Diseases Afflicting Livestock

While overall rainfall projections remain uncertain, it is projected that there will be increased rain in the wet season and increased drying due increased temperatures in the dry season, even if rainfall patterns remain the same. Both scenarios (warmer and wetter or warmer and drier) have significant implications for the livestock sector.

Under *warmer and wetter conditions projected during the wet season*, risks include:

- Increased outbreaks of Rift Valley Fever and expansion into new areas (sheep and cattle, lower increased risk for goats)
- Increased gastro-intestinal helminths burden leading to increased losses (sheep, goats, lower increased risk for cattle)
- Increased lumpy skin disease occurrence among cattle
- More severe sheep and goat pox and orf (*Pustular dermatitis*)
- More common foot rot among sheep and goats
- More frequent *Avian coccidiosis* among chickens

Under *warmer and drier conditions projected during the dry season*, risk of certain diseases would diminish while others are projected to increase. Increased risks include:

- Increased anthrax due to longer periods spent grazing on infected pastures (cattle, camel, sheep, goats)
- More frequent Newcastle disease outbreaks among chickens
- Expansion of tropical theileriosis among cattle
- More frequent outbreaks of foot and mouth disease among cattle
- Increased occurrence of highly pathogenic avian influenza

Rangeland conditions are a primary concern for livestock production. A combination of climate and land use factors drive existing land degradation in Burkina Faso; today, nearly half of all available land is considered degraded with loss of vegetation cover and/or diminished soil carbon and nutrients. Additional drying associated with increased evaporation, heavy rainfall leading to floods, and the potential that droughts will become more marked threaten to exacerbate land degradation and reduce livestock water sources. Drier pasture conditions render grasslands vulnerable to shrub encroachment and reduce rangeland resilience. Floods erode vegetation and the region's already shallow soils, negatively impacting rangeland productivity. Nevertheless, West African rangelands have shown resilience after drought. Long-term field studies, for example, demonstrate a cyclical pattern of vegetation change and the return and diversification of vegetation in the decades after the severe 1984 drought. (8, 9, 17, 31, 32, 36, 37, 38, 43, 46)

Table 4: LIVESTOCK – Climate stressors and risks

Climate stressors	Climate risks
Increased temperatures	Reduced livestock reproduction, growth rates and milk production due to heat stress
Increased duration of heatwaves	Increased expansion, occurrence and outbreaks of certain livestock diseases
Increased evaporation rates	Reduced rangeland and crop productivity, leading to reduced livestock weight and livestock losses during drought (climate shock)
Increased frequency and intensity of heavy rainfall	Drying rangelands, leading to degradation and loss of perennial grasses, diminishing dry season grazing potential (gradually evolving risk)
Increased length or intensity of dry periods	Increased evaporation and longer dry periods, leading to early drying or loss of seasonal water sources
	Altered pastoral mobility patterns, increasing conflict with farmers

HUMAN HEALTH, NUTRITION, AND WASH (WATER, SANITATION AND HYGIENE)

Health indicators in Burkina Faso improved over the past 25 years but continue to demonstrate the hardships faced by populations across the country. Life expectancy is 59 years and infant and under-five mortality rates are high (61 and 89 per 1,000 live births, respectively), with higher rates in rural areas. A 2016 survey indicates that 19 percent of children under five are underweight while 27 percent experience chronic malnutrition. Across Burkina Faso, 19 percent of rural women are malnourished while 58 percent of rural pregnant women have anemia. Health issues are exacerbated by a weak health care system, poor hygiene and sanitation practices and a dispersed population, particularly in the Sahel and East Regions. Increased risk from heat waves, infectious diseases, flooding, diminished water quality and availability (including limited WASH infrastructure), and food insecurity are the most pressing climate-related challenges to human health and nutrition in the FFP program areas.

Longer and hotter heat waves, in addition to overall warmer temperatures, increase heat stress, as well as the risk of cardiovascular and respiratory disease, especially among the elderly. Rising temperatures accelerate reproduction of disease-causing bacteria and disease vectors, such as mosquitos. Nationally, lower respiratory infections (i.e., tuberculosis), malaria and diarrhea are the leading causes of death, all of which are affected by warming temperatures, drier conditions and reduced water quality. Other infectious diseases, such as meningitis, cholera and measles, are also linked to climate (temperature, humidity and rainfall). Climate variability and change will likely

lead to shifts in the distribution, timing and severity of these diseases, particularly malaria and meningitis (associated with dry, dusty weather). Warming trends appear to be expanding the occurrence of meningitis southward in the country, where outbreaks are already a significant threat. From 2001–2008, 28 communicable disease outbreaks occurred countrywide, including meningitis, measles, yellow fever and cholera. (14, 20, 39, 44)

More frequent and intense heavy rainfall increases the risk of flood-related mortality, reduces water quality, and enables destruction of agricultural lands, water infrastructure and homes. In recent years, severe flooding during the wet season was frequent (2007, 2009, 2010, 2012, 2015, 2016), with implications for health. The July–August 2016 floods, for example, affected 27,000 people, washed away livestock and crops, destroyed roads and dykes, flooded improved lowlands, and polluted surface waters across the FFP program area. Flooding, combined with hotter temperatures, can negatively affect water quality, increasing the risk of diarrhea and other waterborne diseases. Diarrhea is already a leading cause of childhood mortality and contributes significantly to undernutrition in children. In rural Burkina Faso, 76 percent of residents have access to improved water sources. However, 75 percent also practice open defecation, increasing the risk of water pollution during heavy rainfall.

Chronic drought in Burkina Faso is a primary driver of both water scarcity and malnutrition. There are no year-round rivers in the north of the country. People thus rely on wells, household tanks and standing water (i.e., Mare Oursi wetland). Wells accessing groundwater are used almost exclusively for household use (rather than irrigation) and withdrawals do not exceed recharge. Research shows that hand pump wells across West Africa are buffered against climate variability in the short term and recharge is still occurring. Domestic renewable water resources, however, are low, estimated at 738 m^3 per capita, well below the estimated scarcity threshold of 1,000 m^3 per capita. The country's geology limits renewable groundwater reserves (estimated at 9.5 km^3 per year), resulting in low success rates for boreholes. In the future, aquifer recharge rates are likely to be reduced by drought, rising temperatures and a greater proportion of rainfall falling in heavy events (leading to increased runoff and decreased infiltration through soils into the groundwater). Meanwhile, population growth and less reliable surface water will increase demand. Reduced water availability forces women and children to walk long distances to meet domestic needs, with secondary impacts on livelihoods and health. Recent drought impacts on nutrition are also substantial. During the 2011–2012 drought, for example, the number of undernourished people countrywide increased from 3.8 million (2008–2010) to 4.4 million (2011–2013), about a quarter of the population. This same drought left 450,000 children under five severely malnourished and 100,000 with severe acute malnutrition, many in the Sahel region. (1, 6, 8, 10, 11, 15, 20, 26, 39, 41, 42, 44, 47, 49, 50)

Table 5: WASH AND HEALTH– Climate stressors and risks

Climate stressors	Climate risks
Increased temperatures	Increased heat wave and heat stress-related mortality and morbidity (i.e., cardiovascular and respiratory diseases, heat exhaustion, heatstroke)
Increased duration of heat waves	Expanded ranges of disease vectors (e.g., mosquitos) and increased transmission of infectious diseases such as meningitis and malaria

Increased frequency and intensity of heavy rainfall	Increased flood-related mortality and morbidity, including an increase in infectious diseases from degraded water quality; increased damage to water and sanitation infrastructure
Increased length or intensity of dry periods	Reduced water availability due to drying water sources over longer dry periods
	Diminished nutrition and food security from flood and drought

PESTICIDE USE

Chemical pesticide use is generally low in Burkina Faso, with most of the pesticides applied to cotton and other high-value crops, mainly in the south. The use of chemical pesticides and fertilizers also appears to be decreasing, following the country's international commitments (i.e., Pesticides Trade Convention, Basel Convention on Toxic Waste Exports, Stockholm Convention on Persistent Organic Pollutants). Banned pesticides containing dieldrin, endosulfan and heptachlor and restricted pesticides containing HCH, lindane and monocrotophos, however, are available to farmers in parts of the Sahel. Pests and diseases cause significant agricultural damage every year and it is possible that farmers will respond by increasing pesticide use. The adverse impacts of climate stress on agricultural production could also incentivize farmers to increase pesticide use. Increased frequency and intensity of heavy rainfall, meanwhile, could reduce pesticide effectiveness and increase pesticide contamination. More than 180 herbicides, insecticides and fungicides are used in the country, many of them not authorized for sale. Risk of pesticide contamination in soils and surface water and groundwater is high given weak regulations on pesticide use, lack of awareness regarding safe use (and lack of labeling about safe and effective use), and poor soils that lead to high rates of water runoff during heavy rainfall events. Pesticide contamination causes poisoning in people and can have adverse ecological impacts. Most pesticide use is related to cotton production, with limited quantities used in subsistence farming. (5, 23, 25)

Table 6: PESTICIDE USE – Climate stressors and risks

Climate stressors	Climate risks
Increased frequency and intensity of heavy rainfall	Increased surface runoff
	Increased infiltration of pesticide residues into groundwater table
Increased temperatures	Increased threat from, or introduction of, pests and diseases
Increased evaporation rates	Reduced effectiveness of pesticides applied topically
	Reduced effectiveness of pesticides that are activated/distributed by water
Increased length or intensity of dry periods	Farmers' reduced willingness to use Personal Protective Equipment (PPE) due to increased temperatures

INVASIVE SPECIES

Invasive species are often highly adaptable and can respond positively to rising temperatures and variable climate conditions. Some initiatives have even promoted certain invasive species because of these very characteristics, to the detriment of land productivity, biodiversity and ecosystem function. Guidance from the Bureau for Democracy, Conflict, and Humanitarian Assistance (DCHA)

Environmental Officer specifically prohibits USAID support for promotion of any invasive species. Many invasive plants are early-maturing and may thus capture a larger share of nutrients, water and pollinators, outcompeting crops and native species. Additionally, invasive species can often establish in degraded lands. Converting native vegetation to agricultural land disturbs the soil and disrupts plant communities, giving invasive species an opportunity to proliferate. Problematic invasive species reduce crop and livestock production, displace native biodiversity and increase production costs. Although specific information on invasive species in northern Burkina Faso is lacking, anecdotal evidence suggests that *Chromolena odorata* and *Eichorniae crassipes* (water hyacinth) already threaten grasslands, shrub lands, savannahs, dry forests, rivers and wetlands. The species known to be present in Burkina Faso are described in Table 7. (2, 16, 18, 19, 38, 45)

Table 7: INVASIVE SPECIES – Characteristics and link to climate

Species	Characteristics	Link to Climate
Prosopis juliflora	Perennial, deciduous, fast-growing, nitrogen-fixing and very salt- and drought-tolerant shrub or tree with deep tap roots; grows in arid and semi-arid environments, forms dense stands and outcompetes native vegetation	Has shown increased distribution under increasing temperature and long dry periods in Kenya
Chromolena odorata	Perennial shrub; forms dense thickets; competes with crops and native species; presents fire risk during the dry season	Highly adaptable to variable rainfall in the range of 600–2,000 mm
Eichorniae crassipes (water hyacinth)	Aquatic species of a few centimeters to over a meter in height; forms dense floating mats that impede water flow and create mosquito breeding areas	Adapted to temperature range of 12°–35°C; seeds can germinate in a few days or remain dormant for 15–20 years to survive variable conditions

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