2 Commodities

2.1 Banana

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The importance of banana (*Musa* sp) for food and nutrition security

Banana is grown in the humid and subhumid tropics, the tropical highlands, and even in the drier subtropics. In terms of production, bananas are the world's fourth most important food crop, mostly grown and consumed in the tropical and subtropical zones. The banana's ability to produce fruits all year round makes it an important food security crop and cash crop in the tropics. The crop is grown in more than 120 countries; around a third each is produced in the African, Asia-Pacific, and Latin American and Caribbean regions. As shown in Table 2.1.1, three categories of bananas are produced. Plantains and cooking bananas are staple foods, while dessert bananas are an important source of calories, minerals (such as potassium) and vitamins consumed as a fruit.

The data in the table do not include production of export bananas. The production figures per capita can therefore be considered the production available for domestic consumption. About 87% of all the bananas grown worldwide are produced by small-scale farmers for local consumption as a food security crop, and for local markets rather than for international trade. They provide a staple food for millions of people, particularly in Africa. The regional figures do not highlight the subregions for which bananas are an important staple. Bananas and plantains supply more than 25% of the carbohydrate requirements for over 70 million people in Africa. These include parts of Uganda, Tanzania, Burundi, Rwanda and Eastern DRC for which East Africa Highland bananas are a staple food consumed in some localities two to three times per day. East Africa is the largest banana-producing and consuming region in Africa with Uganda being the world's second leading producer after India, with a total production of about 10.5 Mt. In some African countries such as Uganda the daily consumption of banana may exceed 1.6 kilogrammes per person, which is the highest in the world.

The plantain zone of Nigeria, Ghana, Côte d'Ivoire and Cameroon figures into the averages for West and Middle Africa. In Asia, the vast majority of cooking bananas is consumed in the Philippines. Papua New Guinea is the major consumer of cooking bananas in Melanesia, while countries such as Colombia and Peru have high per capita consumption of plantains in Latin America.

Table 2.1.1. Banana statistics by region

Region[1]	Average production per year ('000 Mt)[2]				Per capita production (kg)	Average area (1000 ha)	Average yield (t/ha)
	Dessert banana	Plantain	Cooking banana[3]	Total			
Year	2006	2006	2006	2006	2006	2006	2006
Eastern Africa	2538	1275	13371	17184	58.7	3559	4.8
Northern Africa	1650	0	9	1659	8.5	30	56.0
Middle Africa	1334	2577	484	4395	38.5	902	4.9
Southern Africa	343	0	0	343	6.2	7	46.5
Western Africa	1396	6340	657	8393	30.6	1336	6.3
Africa (Total)	7261	10192	14520	31973	34.3	5835	5.5
Central America	2799	958	142	3900	26.5	250	15.6
South America	10006	5330	708	16044	42.7	1590	10.1
Caribbean	1030	934	597	2561	63.2	296	8.6
Americas (total)	13835	7222	1447	22504	39.9	2137	10.5
East Asia	6527	1	460	6988	4.5	296	23.6
South Asia	10341	629	2337	13308	8.3	751	17.7
Southeast Asia	7087	204	7213	14504	25.6	1094	13.3
Melanesia	100	1	514	615	76.8	65	9.4
Micronesia	2	0	5	8	14.5	2	3.1
Oceania	265	0	1	266	10.7	11	23.8
Polynesia	15	0	25	40	67.8	6	6.2
Asia (total)	24337	836	10554	35727	9.5	2226	16.0
Total: 3 continents	45434	18250	26521	90204	17.2	10198	8.8

Source: Lescot (2008) and FAOSTAT

[1] Excludes North America, Central Asia and Europe

[2] Fruitrop Market News for 2007 (passionfruit.cirad.fr/index.php/recherche/(produit)/1): Musa (bananas and plantains) domestic production (with exports deducted) - so production available for domestic consumption

[3] Highland bananas + ABB cooking bananas + others

Approximately 13% of worldwide banana production is destined for the export market. The banana fruit is extremely important as an export commodity especially in Latin America and Caribbean, which contribute over 83% of the total banana in the international market. The banana export industry is also the backbone of the economies of many Caribbean countries, and the crop plays a vital role in the social and political fabrics of the islands. In Africa, only five countries, namely Côte d'Ivoire, Cameroon, Somalia, Ghana, and Cape Verde, export approximately 427,000 t of banana and plantain. There are more than 500 banana varieties in the world, but the Cavendish is the most exported banana cultivar.

Nutritionally, fresh bananas contain 35% carbohydrates, 6–7% fibre, 1–2% protein and fat, and major elements such as potassium, magnesium, phosphorus, calcium, iron, and vitamins A, B6 and C. Bananas are also used to manufacture beer, wine and other products and form an important part of the cultural life of many people.

Biological vulnerability to climate change

Bananas, plantains and cooking bananas are an herbaceous semi-perennial vegetatively propagated crop. The production cycle for a single bunch varies from 10 to 20 months, depending on temperature and water availability. Farmers have developed diverse production systems in different environments to overcome climatic constraints on banana productivity, including irrigation; protective covers, planting density and sucker management and season of planting and production. Smallholders depending on rainfall will be the most affected by changing climate, primarily due to their lack of resources to adapt production practices and due to changes in pest and disease occurrence.

The following parameters define banana and plantain growth. Cultivar groups are known to have somewhat different responses to climatic factors.

- The optimum temperature range is 20–30˚C. Extended periods outside this range reduce production per ha. In the 20–25˚C range, larger bunches and longer vegetative period are achieved; in the 25–30˚C range, smaller bunches with a shorter cycle occur. Total yield per ha through time is generally stable from 20–30˚C.
- Temperatures above 35˚C and below 10–15˚C cause damage to plant tissue and distort flowering emergence and bunch filling. If extreme temperatures do not persist beyond 2–4 days, plants recover, although bunches emerging during the period of stress may not fill

properly. Temperatures below 2–3˚C for several days are lethal to the plant, which does not recover. Cultivar differences have been observed for temperature response. This cultivar difference can be seen in the highland tropics. Certain cultivars are found primarily at low elevations, while other cultivars continue to be grown even above 2000 meters above sea level. The East African Highland bananas have been selected by farmers for their performance in tropical highlands, although climate change may be detrimental by increasing the temperature above their optimal range.

- For temperatures that are outside of the optimum range but not extreme, total production declines due to increased crop cycle length, either due to lower rate of degree, day accumulation or increased respiration.
- Banana is highly sensitive to available soil water. The roots sense slight water deficits, which cause the leaf stomates to close to reduce water loss. This occurs at higher soil water levels for banana and plantain than for many other crops. Banana is therefore a low user of water below optimum and can survive for long periods of drought, only resuming vegetative growth quickly when soil moisture reaches an optimum.
- Optimum rainfall for banana growth is 1300–2600 mm per year distributed equally at 100–200 mm per month, although actual water use is a function of potential evapotranspiration.
- Periods of sub-optimum soil moisture slow the rate of leaf emergence. Bunch size can be affected by lack of moisture, if this occurs during or after flowering, but yield also declines due to the increasing length of the vegetative period under below optimum moisture.

Based on this summary of banana response to climatic parameters, the impact of climate change on banana production can be hypothesized. The effects were projected by Ramirez et al. (2011), although the limitations of the ECOCROP model for semi-perennial crops were described in greater length by Ramirez et al. (2012).

Suitability for banana increases in the sub-tropics due to increases in winter temperatures and a decline in the frequency of frosts and cold snaps. The upper altitudinal limit for banana cultivation in highland tropics will increase due to increasing temperatures. The time from planting to harvest at intermediate altitudes in the tropics will decrease, although bunch size may also decrease. Higher temperatures will also increase the water demand for highland

bananas. Productivity of bananas in lowland tropics may decline in those areas with extended periods of temperatures above 30˚C.

The effects of changes in precipitation are harder to project. Greater irregularity of rainfall and declining rainfall will increase the length of the crop cycle and the seasonality of bunch production. Figure 2.1.1 shows that some areas are predicted to have an increase in rainfall, while others are predicted to receive less rainfall. Certain areas of the Caribbean and Central America may experience reductions in rainfall of 150–200 mm per year by 2020.

Figure 2.1.1. Expected changes in precipitation and temperatures in banana-growing areas of the world by the 2020s for the SRES-A2 emission scenario: average of four GCM patterns.

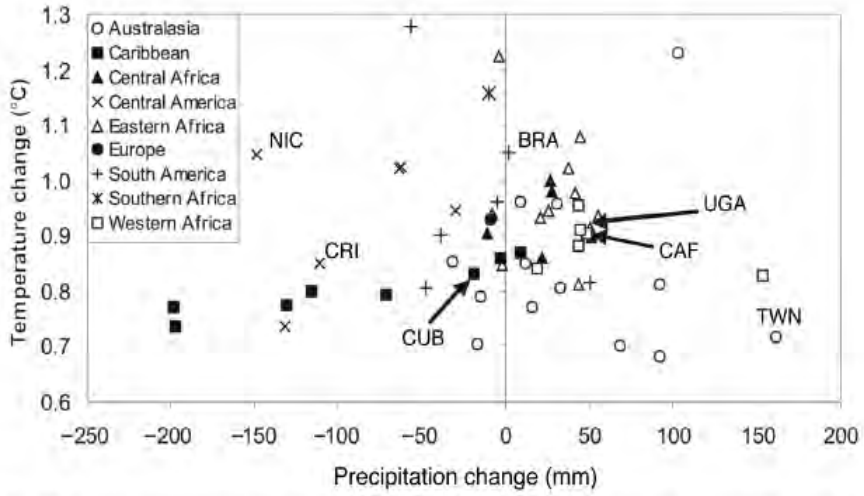


Fig. 20.2. Expected changes in precipitation and temperatures in banana-growing areas of the world by 2020s for the SRES-A2 emission scenario as average of four GCM patterns.

Source: Ramirez et al. (2011).

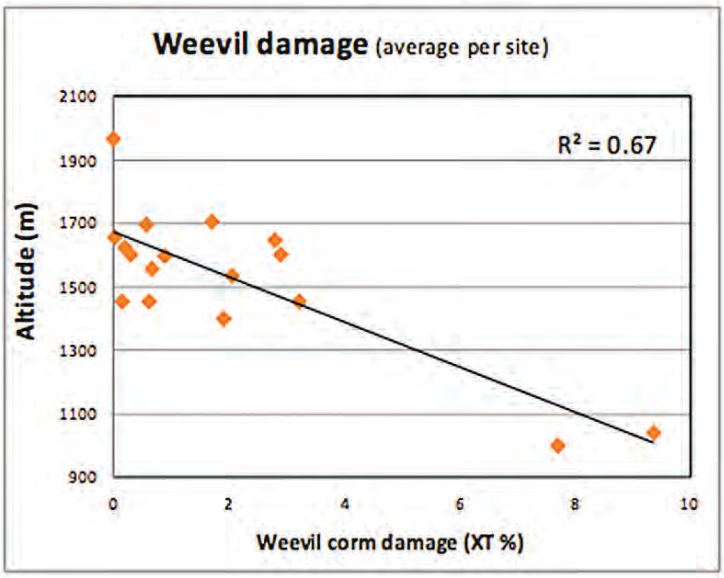
Recent studies on bananas in East African highland bananas suggest that banana yields might continue to increase with increasing rainfall, at least until 1500 mm per year. For the East African highland bananas, yield losses of 9% were observed per 100mm annual rainfall decrease (Van Asten et al. 2011).

Banana pests and diseases such as black leaf streak and banana bunchy top virus vectored by the banana aphid can be expected to expand into higher altitudes and into the subtropics with increases in average annual temperatures. In lowland areas, more complex interactions with rainfall and relative humidity make predictions of the impact of climate change on the severity of black leaf streak more difficult. Other pests which have temperature-dependent life

cycles may also become more severe as temperatures increase in mid- and high-altitude and subtropical production areas.

Highland banana areas that are currently little exposed to nematode, weevil, and sigatoka problems will significantly see yield losses increase (Figure 2.1.2). The major highland banana production areas are currently located over 1300 m above sea level. Weevil damage is still very low or absent at these altitudes. In lower areas, maximum yield is limited by weevils, with approximately 4% banana bunch weight loss per percentage point of weevil corm damage (XT). If temperature increases by 2°C, then the major production areas will be infected and yield losses due to weevils are estimated to increase to 30% or more. Similarly, Radophilis similis nematodes are currently limited to elevations below 1300 m and can cause up to 50% yield loss. Yield response curves are not yet established, but it is estimated that nematodes can contribute to yield losses in the same order of magnitude as weevils. Black sigatoka is currently the biggest plant health constraint in the major lowland production areas and this fungal foliar disease will also become more important in the highland areas. However, little is known about the effects of temperature on interaction with biocontrol agents.

Figure 2.1.2. Corm damage caused by the banana weevil (Cosmpolites sordidus [Germar]) is low at altitudes >1400 m, but average corm damage can reach close to 10% around 1000 m altitude, translating to yield losses of up to 30%.



Source: Based on CIALCA-I technical report (2006-2008) at http://www.cialca.org/ files/files/CIALCA-I_final_technical_report.pdf

Besides increased problems with drought, pests and diseases, bananas are sensitive to extreme weather events such as hailstorms, droughts, floods, and strong winds. These are likely to increase in the future. No information is available on the effect of CO_2 concentration changes on banana productivity.

Socioeconomic vulnerability to climate change

In terms of vulnerability, bananas provide a buffer function in the farming systems. Short drought events at critical periods of annual crops may severely affect their yields, whereas bananas remain much more stable, albeit with yield losses as well. The biggest threat of climate change is an increase of pest and disease outbreaks, particularly in highland areas where farmers currently have bananas as their primary staple. For example, the genetic base of East African highland bananas is very narrow, and new pest and disease dynamics, triggered and/or enhanced by climate change will severely threaten the sustainability of these important buffers in smallholder farming systems.

The highlands of Uganda, Tanzania, Burundi, Rwanda and Eastern Congo stand out for their dependence on bananas for food security. Over 30 million people in poor households consume bananas as frequently as twice a day. This area is highly vulnerable in terms of percentage of poor households with limited resources and the challenges faced by national governments. The area is composed of many microclimates depending on proximity to the lakes, geological origin of soils, and altitudes that vary from 1000–2000 m above sea level, which makes climate change projections somewhat general. Temperatures are projected to increase, which will upset a delicate balance between bananas, annual rainfall (which is near the lower limit for banana production) and evapotranspiration. The increased temperatures may increase the pressure from black leaf streak disease and accelerate the reproduction rate of banana weevils and nematodes, three problems which are kept somewhat in check currently in production areas above 1400 m elevation. The projected increase in rainfall may be positive in offsetting the increased evapotranspiration from higher temperatures, but higher humidity may make conditions more favorable for black leaf streak. In summary, the highland banana areas of Uganda and Great Lakes Central Africa are potentially highly vulnerable, but climate change modelling needs to continue at a finer scale with greater attention to the interaction with pests and diseases and crop productivity.

A second area stands out globally for the importance of bananas in household nutrition. Over 12 million people in poor households of West and Central Africa consume plantains as an important component of their diet. While these households have a more varied diet than the banana-dependent households of East and Central Great Lakes Africa, plantains are a major component of the diet. Up to 100 kg per year of plantain are consumed per person in plantain-growing regions of Guinea-Conakry, Côte d'Ivoire, Ghana, Nigeria and Cameroon. The West Africa forest belt where plantain production is located will experience increasing temperatures, which characterize climate change globally. In these lowland areas temperatures are project to exceed 30˚C more frequently, with detrimental effects on total productivity. Increasing temperatures with similar, but possibly more erratic, rainfall will subject plantain gardens to greater water stress with a decline in productivity. This situation may reduce the pressure from black leaf streak with an unclear balance for overall production and household food security, which depends on plantain.

Few areas of Asia and Latin America have such high levels of dependence on bananas and plantains as found in these two zones. In Asia, the Philippines, where bluggoe-type cooking bananas are an important food item, stands out in vulnerability to climate change, including cyclones, floods and droughts.

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