



Spatial Implications of Climate Change on Land Allocation and Agricultural Production in ECOWAS

Boris K. Lokonon
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Abstract

Climate change is one of the most serious threats to food security in the future. Indeed, agriculture in developing countries is predicted to be seriously impacted by climate change, and the magnitude and the direction of the impacts vary across countries. This paper takes advantage of agro-climatic zones to investigate the impacts of climate change on land allocation and crop production in the Economic Community of West African States (ECOWAS). A regional mathematical programming model is used to simulate the implications of climate change on crop acreage and crop production following two Representative Concentration Pathways and four prevailing socio-economic conditions. The findings suggest that acreage will be lower, higher, or remain the same depending on the crops and the future conditions (combinations of climate and socio-economic scenarios). In terms of crop production, results showed that paddy rice, maize, sorghum, millet, oilseeds, cocoa, coffee, and sesame production experience a decline under both moderate and harsh climate change in most cases. The magnitude and the direction of the impacts vary across geographical units. The findings of this study advocate for international action in terms of reducing the emission of greenhouse gases (GHG) in developing countries. Moreover, it is urgent to develop adequate adaptation strategies to offset the negative impacts of climate change.

Keywords: Agricultural Production, Agro-climatic Zones, Bioeconomic Model, Climate Change, Land Allocation

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List of Acronyms

ACZs	Agro-climatic zones
AEZs	Agro-ecological zones
ASM	Agricultural Sector Model
CMIP5	Coupled Model Intercomparison Project, Phase 5
DTR	Diurnal Temperature Range
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GTAP	Global Trade Analysis Project
IPCC	Intergovernmental Panel on Climate Change
PMP	Positive Mathematical Programming
RCM	Regional Climate Model
RCPs	Representative Concentration Pathways
SDGs	Sustainable Development Goals
SSPs	Shared Socio-economic Pathways
SWAP	Statewide Agricultural Production Model
TASM	Taiwan Agricultural Sector Model
U.S.	United States of America
WAEMU	West African Economic and Monetary Union
WDI	World Development Indicators

Introduction

Climate change (CC) is one of the serious threats recognized to hamper the ability of food supply systems to meet growing demand globally and especially in sub-Saharan Africa (SSA) (Parry *et al.*, 2004; von Lampe *et al.*, 2014; Leclère *et al.*, 2014). Climate change adds further pressure to the existing daunting challenges such as extreme poverty and hunger (Nelson *et al.*, 2010). Indeed, climate change is expected to hamper food production in the future, and by the same token, may influence the achievement of the Sustainable Development Goals (SDGs). It is recognized as being already reducing the productivity of major crops, and will greatly affect agricultural supply (Gornall *et al.*, 2010; Roudier *et al.*, 2011; Di Falco *et al.*, 2012; Challinor *et al.*, 2014; Rosenzweig *et al.*, 2014; Leclère *et al.*, 2014; IPCC, 2014a,b).

Agriculture in developing countries, which is mainly rain-fed, is predicted to be seriously impacted by climate change (Tol, 2002; Fischer *et al.*, 2005; Mendelsohn *et al.*, 2006). Unlike the net revenue from African crops that was predicted to likely fall with warming, the net revenue from African livestock was predicted to increase in many situations (Seo & Mendelsohn, 2008a, b; Seo *et al.*, 2009). Moreover, CC, is expected to provide opportunities for improvements in certain aspects of farming systems (Gornall *et al.*, 2010). According to Seo (2013), it is possible for farmers to be prepared for CC, but there is little effort on their part to cushion the effects of weather shocks. Therefore, it is necessary to identify the most relevant adaptation strategies to help farmers adapt to climate shocks. However, to identify the appropriate adaptation strategies there is a need to

first evaluate the magnitude of climate change threats. There is a variety of economic models that have been developed to investigate the effects of CC on agricultural production. These models span from large-scale (Butt *et al.*, 2005; Medellin-Azuara *et al.*, 2011; Leclère *et al.*, 2014) to small-scale bio-economic models (Pinky & Rayhan, 2013, Lokonon *et al.*, 2015). In addition to impact evaluation, bio-economic models are used for policy simulations such as agricultural and adaptation policy simulations (Barbier & Bergeron, 1999; Judez *et al.*, 2001; Bartolini *et al.*, 2007; Cortignani & Severini, 2009; Louhichi *et al.*, 2010a; Janssen *et al.*, 2010; Sanfo & Gérard, 2012; Louhichi & y Paloma, 2014) and environmental policy simulations (Dolisca *et al.*, 2008; Hellwinckel *et al.*, 2010; Janssen *et al.*, 2010; Louhichi *et al.*, 2010b; Belhouchette *et al.*, 2011; Egbendewe-Mondzozo *et al.*, 2011; Bamière *et al.*, 2011, Egbendewe-Mondzozo *et al.*, 2013; Chen *et al.*, 2014; Egbendewe-Mondzozo *et al.*, 2015).

Although earlier studies provide useful measures of the impact of climate change on agriculture at either a continental or national scale in Africa, there remains a question of how these effects vary across the landscapes (Seo *et al.*, 2009). The effects of climate change will differ across agro-ecological (AEZs) and agro-climatic zones (ACZs) in Africa (Seo *et al.*, 2009; van Wart *et al.*, 2013). The Food and Agriculture Organization (FAO) of the United Nations define AEZs as geographic units having similar climate and soils for agriculture, and ACZs as divisions of a region based on homogeneity in weather variables that have the greatest influence on crop growth and yield (van Wart *et al.*, 2013). In other words, while AEZs help broadly define environments where specific agricultural systems may thrive, and ACZs seek to more adequately distinguish between the diversity of practices for similar

agricultural systems within the larger agro-ecological zones, primarily in terms of different climates (van Wart *et al.*, 2013). Given that soil characteristics are also important determinants of agricultural systems, an agro-climatic and soil zone (ACSZ), which contract similar agricultural systems within the large agro-climatic zones, primarily in terms of different soils, represents an appropriate geographical unit to upscale, within time and space, existing or new farming methods based on crop yields.

This paper aims to shed light on the implications of climate change in terms of land allocation and crop production across ECOWAS countries through a bio-economic model built from ACSZs. Specifically, the following research questions are addressed:

- What are the spatial implications of climate change on crop land allocation in ECOWAS countries?
- To what extent will crop production be affected by CC across these countries?

The paper is innovative as it incorporates both socio-economic and climate scenarios into a regional bio-economic model with a detailed time-space dimension of climate and soil in West Africa where there is good quality data. Therefore, it is possible to compare various geographic units in West Africa in terms of land allocations and agricultural production under different socio-economic and climate scenarios.

The remainder of the paper is organized as follows: section 2 describes the main components of the bio-economic model and the main results are presented in section 3. The paper concludes with a discussion of key findings, policy implications as well as implications for future research.

Materials and methods

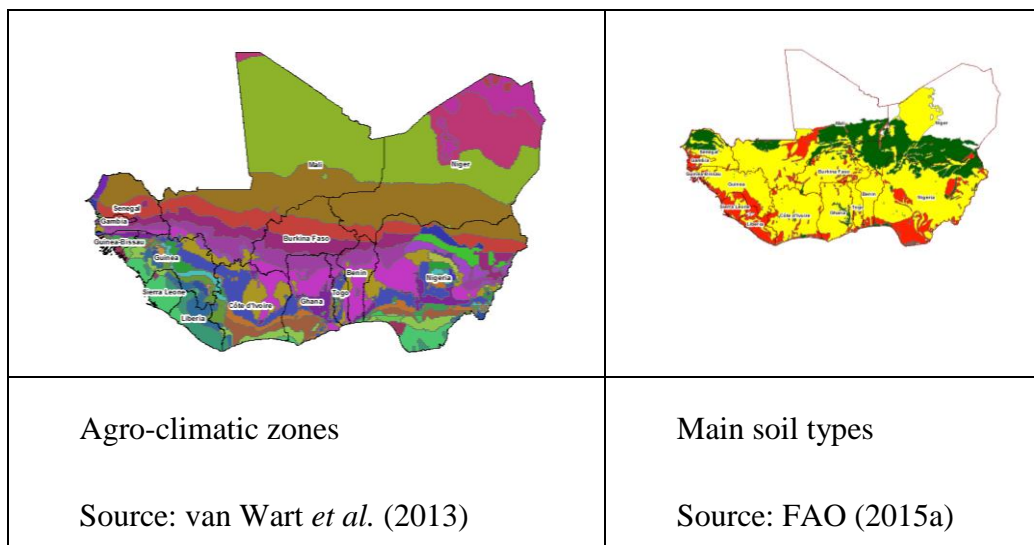
Study area

The study was carried in the ECOWAS region of West Africa (

Figure 1. Maps of ACZs and soils types in ECOWAS countries). The region includes 15 countries, namely Republic of Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. The ECOWAS region covers 5.1 million square kilometres of land area, and its population in 2014 was estimated to be about 339,860,900 million. Agriculture is the major source of livelihood in these countries, and it employs 60 percent of the labour force; it contributes only 35 percent to the Gross Domestic Product (GDP) (Jalloh et al., 2013). Farmers in ECOWAS member countries produce mainly for subsistence due to poverty and they face numerous constraints such as changing climate, soil acidity, and nutrient depletion and soil degradation which negatively affect agricultural development in the region (Jalloh et al., 2013). The main food crops grown and consumed in the ECOWAS member countries are: cereals (maize, sorghum, millet, and rice), roots and tubers (cassava, sweet potatoes, and yams), and legumes (cowpeas and groundnuts), while the major cash crops are cocoa, coffee, and cotton (Jalloh et al., 2013). The region is divided into 39 ACZs (Sebastian, 2014). The major soil types are (

Figure 1. Maps of ACZs and soils types in ECOWAS countries).

Figure 1. Maps of ACZs and soils types in ECOWAS countries.

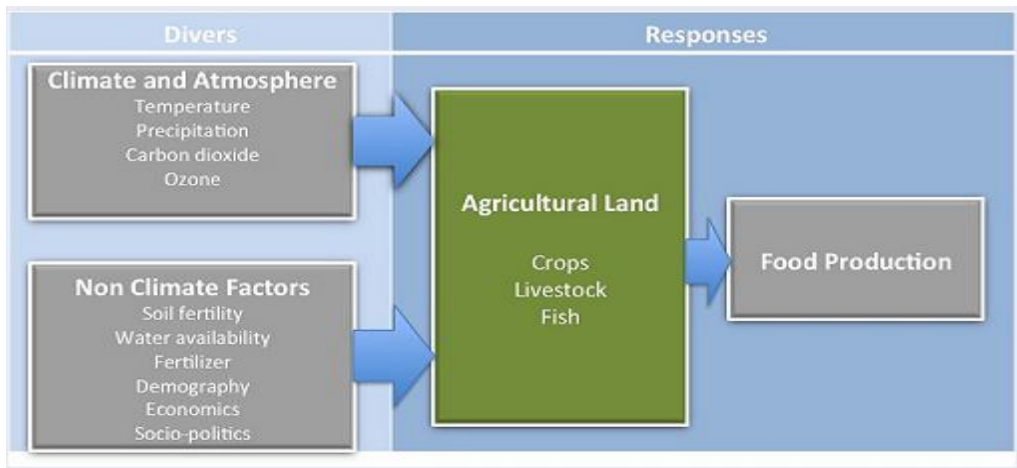


Model

This research uses a bioeconomic model with a representative risk-neutral and profit maximization economic agent. The model integrates biophysical-geographic information system (GIS) in a regional economic mathematical programming model (hereafter ECOLAND). ECOLAND is built from previous regional bio-economic models in a multi-product partial equilibrium framework (McCarl & Spreen, 1980; Chang, 2002; Spreen, 2006). For example, the Agricultural Sector Model (AMS) which is a spatial mathematical programming model for the United States (U.S.) agricultural sector, was used to simulate market equilibrium effects for resources (land, water and labor) and commodities (domestic use, imports and exports of primary and secondary or processed items) (Attwood *et al.*, 2000; Chang *et al.*, 1992). The Taiwan Agricultural Sector Model (TASM) which is a price-endogenous spatial equilibrium model, was used to assess the impact of crop

yield changes on Taiwan regional production, land use, welfare distribution, as well as the potentials for Taiwan agriculture to adapt to climate change (Chang, 2002). Howitt *et al.* (2009) used the Statewide Agricultural Production Model (SWAP), a price-endogenous optimization model calibrated with the Positive Mathematical Programming (PMP) approach, to estimate revenue impacts of climate change in California. ECOLAND is a strictly supply-oriented model which considers climate and atmosphere factors such as temperature, precipitation, and CO₂ as well as non-climate factors such as soil fertility, demography and output prices as exogenous variables (Figure 2. Conceptual framework of the ECOLAND). Indeed, ECOLAND does not consider the relationship between price responses and induced supply changes. Crop yields are supplied to the bio-economic model by an econometric crop simulator component. The GIS component supplies parameters relative to the ACSZs such as croplands and livestock lands. The economic mathematical programming model is a spatial optimization model which uses crop yields and lands from the first two components.

Figure 2. Conceptual framework of the ECOLAND.



Source: UNU-INRA (2014)

Crop yield model

Crop yields are generated using climate change outputs from two Representative Concentration Pathways (RCPs). Following Chang (2002), this study adopts a multi-regression approach for crop yield generation. Average crop yields from the 39 ACZs and for the three types of soils in ECOWAS region for the year 2004 were used in the econometric regressions. The econometric approach is adopted due to the interest of this paper, which is to estimate the values of the crop yields based only on changes in environmental conditions such as climate. The model do not account for crop rotation and other management practices that may improve or deteriorate environmental conditions such soil nutrient content This study assumes that crop yields are dependent only on climate and soil conditions,

and CO₂ concentration in the atmosphere.¹ Indeed, agriculture is mainly rain-fed in ECOWAS countries, and the use of technologies and fertilizers is not widespread. However, after estimating crop yields variation may arise depending on environmental conditions, hence, in the study, we adjusted the result to account for technological change effects. The model in its general form is presented as follows:

$$Y_{it} = Z_{it} CO2_t^{\delta} \left(\prod_{j=May}^{Oct} T_{ijt}^{\alpha_j} \right) \left(\prod_{j=May}^{Oct} P_{ijt}^{\beta_j} \right) \left(\prod_{k=1}^9 S_{ik}^{\gamma_k} \right) \quad (1)$$

Or in logarithmic terms:

$$\log(Y_{it}) = \log(Z_{it}) + \sum_{j=May}^{Oct} \alpha_j \log(T_{ijt}) + \sum_{j=May}^{Oct} \beta_j \log(P_{ijt}) + \sum_{k=1}^9 \gamma_k \log(S_{ik}) + \delta \log(CO2_t) \quad (2)$$

where i and t are respectively the agro-climatic and soil zones index and time index, Z_{it} is the technological progress, T_{ijt} is the monthly main temperature, P_{ijt} is the monthly main precipitation, S_{ik} is the soil characteristics, and $CO2_t$ is the CO₂ concentration in the atmosphere at time t .

The dynamic of the technological progress² is given by

$$\log(Z_{it}) = 0.06 * \left(\frac{t}{1+t} \right)^{60} + 0.98 * \log(Z_{it-1}) + U_{it} ; Z_{i0} = 1 \quad (3)$$

¹It is worth noting that as this study does not follow the duality approach (Segerson & Dixon, 1999), prices are not included in the model.

² The idea behind the technological progress is yield can increase by 1% each year. To avoid non-stationary process, technological change is captured by equation 3.

Where U_{it} is a white noise with a truncated normal distribution $\mathcal{N}(0, 0.005, [0, +\infty[)$.³

GIS component of the bio-economic model

GIS is used to design a consolidated map of ACZs, soils, land uses, countries, river basins, and river sub-basins. Agricultural production decisions take place at the ACZ level. However, country-level, basin-level and sub-basin level information in regards to their share of ACZs are necessary to aggregate agricultural land allocation and agricultural production at country, sub-basin and basin levels. Due to technical constraints, we consider only five of the major basins which are in ECOWAS namely Niger basin, Volta basin, Gambia basin, Senegal basin, and Lake Chad basin⁴. ACZs' crop and livestock land information were obtained from the land use map (Sebastian, 2014; FAO, 2015a; van Wart, et al., 2013) to compute land shares, which are used as aggregation coefficient for the modeling outputs.

Economic mathematical programming model

We consider a farming system characterized by seven cropping systems and four livestock types. The cropping systems were paddy rice, cereals (maize, sorghum, and millet), vegetable and fruits (bananas, cassava, plantains, potatoes, sweet potatoes, and yam), oil seeds (beans, cashew nuts, cowpeas,

³ Refer to Atewamba (in press) for details on crop yields simulations.

⁴ The results of the basins and sub-basins are not reported. However, these results are available upon request.

groundnuts, and soybeans), sugarcane, cotton and other crops (cocoa, coffee, and sesame), as in the Global Trade Analysis Project (GTAP) classification of crops. The livestock types were cattle, sheep, chicken and others. The empirical model is built on the assumption that farmers have to select portfolio of the seven cropping systems and the four livestock types by allocating land, labor, and financial resources to maximize the discounted farm profit for each ACZ. The mathematical programming model is expressed as:

$$\begin{aligned}
 \text{Max}_{xcrop_{z,c,s,ty}, xliver_{z,r,ty}, tlab_{z,tm,ty}} \quad & \sum_{ty} \left[e^{-0.03ty} \left(\sum_z \sum_r \sum_k (share_{k,z} * xliver_{z,r,ty} * lprice_{k,r,ty}) + \right. \right. \\
 & \sum_z \sum_c \sum_k \sum_s (share_{k,z} * yield_{z,c,s,ty} * xcrop_{z,c,s,ty} * price_{k,c,ty}) - \\
 & \sum_{tm} \sum_z ((fwage_{z,tm,ty} * famlab_{z,tm,ty} + twage_{z,tm,ty} * tlab_{z,tm,ty}) / dpm) - \\
 & \sum_r \sum_z ((rations_{z,r,ty} + vetpr_{r,ty}) * xliver_{z,r,ty}) - \sum_z \sum_c \sum_s (pcost_{z,c,ty} * xcrop_{z,c,s,ty}) - \\
 & \left. \left. \sum_z \sum_c \sum_s \sum_r ((xcrop_{z,c,s,ty} + lio_{s,r} * 1000 * xliver_{z,r,ty}) * landcost_{z,ty}) \right) \right]
 \end{aligned} \tag{4}$$

Subject to

$$\sum_c xcrop_{z,c,s,ty} \leq 1000 * landc_{z,s,ty} \tag{5}$$

$$\sum_r lio_{s,r} * xliver_{z,r,ty} * 1000 \leq 1000 * landl_{z,s,ty} \tag{6}$$

$$\sum_s \sum_c (labor_{c,tm} * xcrop_{z,c,s,ty}) + \sum_r (llab_{tm,r} * xliver_{z,r,ty}) \leq famlab_{z,tm,ty} + tlab_{z,tm,ty} \tag{7}$$

$$\begin{aligned}
 & \sum_c \sum_s (pcost_{z,c,ty} * xcrop_{z,c,s,ty}) + \sum_r (rations_{z,r,ty} + vetpr_{r,ty}) * xliver_{z,r,ty} + \\
 & \sum_{tm} (twage_{z,tm,ty} * tlab_{z,tm,ty}) / dpm + \sum_c \sum_s \sum_r (xcrop_{z,c,s,ty} + lio_{s,r} * 1000 * \\
 & xliver_{z,r,ty}) * landcost_{z,ty} \leq wbar_{z,ty}
 \end{aligned} \tag{8}$$

The sets, parameters, and variables used in the model are defined in Table 1.

The objective function (4) contains six expressions. The first expression $(\sum_{ty} [e^{-0.03ty} (\sum_z \sum_r \sum_k (share_{k,z} * xliver_{z,r,ty} * lprice_{k,r,ty}))])$ is the total discounted livestock revenue⁵. The second expression

(
 $\sum_{ty} [e^{-0.03ty} (\sum_z \sum_c \sum_k \sum_s (share_{k,z} * yield_{z,c,s,ty} * xcrop_{z,c,s,ty} * price_{k,c,ty}))]$
) represents the total discounted crop production revenue from all crops and groups of crops. The third expression

$(\sum_{ty} [e^{-0.03ty} (\sum_{tm} \sum_z ((fwage_{z,tm,ty} * famlab_{z,tm,ty} + twage_{z,tm,ty} * tlab_{z,tm,ty}) / dpm))])$
 is the total discounted labor costs. The fourth expression

$(\sum_{ty} [e^{-0.03ty} (\sum_r \sum_z ((rations_{z,r,ty} + vetpr_{r,ty}) * xliver_{z,r,ty}))])$

represent the overall discounted livestock feeding and veterinary services costs. The fifth expression

$(\sum_{ty} [e^{-0.03ty} (\sum_z \sum_c \sum_s (pcost_{z,c,ty} * xcrop_{z,c,s,ty}))])$ is the overall discounted technology costs. The sixth expression

$(\sum_{ty} [e^{-0.03ty} (\sum_z \sum_c \sum_s \sum_r ((xcrop_{z,c,s,ty} + lio_{s,r} * 1000 * xliver_{z,r,ty}) * landcost_{z,ty}))])$

represents the total discounted land cost. Equation (5) is the expression of cropland resource constraints. Equation (6) represents livestock land resource constraints.

⁵ All animals produced are not supposed to be sold. The expression enables just to account for the total livestock revenue in the objective function.

Table 1. Model sets, parameters, and variables definitions.

Sets, parameters, and variables	Definition
Sets	
c	Set of seven crops and groups of crops studied in the model
r	Set of four livestock types studied in the model
s	Set of three soil types
km	Set of four technologies used in crop production
tm	Set of 12 months of the year
ty	Set of 5-year periods from 2010 to 2100 with 2004 as baseline
z	Set of 39 agro-climatic zones
k	Set of 14 countries included in the analyses
b	Set of five basins included in the analyses
Parameters	
landc_{z,s,ty}	Crop land per ACZ, soil type, and per period (1000 ha)
landl_{z,s,ty}	Livestock land per ACZ, soil type, and per period (1000 ha)
rations_{z,r,ty}	Livestock ration feeding per ACZ, livestock type, and per period (1000 USD)
lio_{s,r}	Land requirement per livestock type, and per soil type (1000 ha per head)
labor_{c,tm}	Labor requirement per crop and group of crops type, and per month (man-days)
llab_{tm,r}	Labor requirement per livestock type, and per month (man-days)
price_{k,c,ty}	Crop prices per country, and per period (1000 USD per ton)
yield_{z,c,s,ty}	Yield of crop c per ACZ, per soil type, and per period (ton/ha)
pcost_{z,c,ty}	Technology costs of crop c , per ACZ, and per period (1000 USD)
fwage_{z,tm,ty}	Family reservation wage per ACZ, month, and period (1000 USD per man-day)
twage_{z,tm,ty}	Hired labor wage per ACZ, month, and period (1000 USD per man-day)
famlab_{z,tm,ty}	Family labor per ACZ, month, and period (man-days)
lprice_{k,r,ty}	Livestock prices per country, and per period (1000 USD per head)
vetpr_{r,ty}	Cost of veterinary services per livestock type, and per period (1000 USD)
landcost_{z,ty}	Land costs per ACZ, and per period (1000 USD)
wcbar_{z,ty}	Working capital per ACZ, and per period (1000 USD)
share_{k,z}	Crop land share of ACZs within countries
dpm	Number of working days per month
Variables	
xcrop_{z,c,s,ty}	Quantity of land in each ACZ allocated to crop or groups of crops c ,

$xliver_{z,r,ty}$	per soil type, and per period (ha)
	Number of animals produced in each ACZ, per livestock type, and per period (head)
$tlab_{z,tm,ty}$	Hired labor to complement family labor per month, and per period in each ACZ (man-days)

Labor resource constraints are accounted by equation (7), and equation (8) accounts for financial resource constraints.

Parameterization of the model

The parameters used in the bio-economic model are from several sources and these are: crop land, livestock land, livestock ration feeding, land requirement per livestock land requirement, crop labor requirement, livestock labor requirement, crop prices, crop yields, technology costs, family reservation wage, hired labor wage, family labor, livestock prices, cost of veterinary services, land costs, working capital requirements, crop land share, and number monthly working days. In addition to crop yields, an intensive desk-survey was used to collect data on the remaining socio-economic parameters required to perform the optimization. Indeed, many socio-economic parameters used in the modeling are from previously published studies (e.g., Louhichi *et al.*, 2013; Louhichi & Paloma, 2014; Lokonon *et al.*, 2015; Yilma, 2006; Kutcher & Scandizzo, 1981; Paloma *et al.*, 2012). Other socio-economic parameters collected were from the World Development Indicators (WDI) (World Bank, 2015) and from the FAO database (FAO, 2015b). Many socio-economic parameters are projected from 2010 to 2100.

This work relies on four socio-economic scenarios to capture our uncertainty about future economic prospects of the region (Palazzo *et al.*, 2014). Scenarios are not projections, predictions, or forecasts; rather they describe

potential future conditions and how they came about (Wilkinson & Eidinow, 2008). Two axes of uncertainty have structured the socio-economic scenarios: (i)- short-term or long-term priorities dominate in regional governance and (ii) the state or non-state actors are the driving force of change in the region, though many other drivers play a key role in the scenario pathways (Palazzo *et al.*, 2014). These other drivers (e.g., population, GDP, political stability) are assumed to occur in each socio-economic scenario to allow for comparisons to be made between them (Palazzo *et al.*, 2014). This paper uses the following four socio-economic scenarios (or Shared Socio-economic Pathways-SSPs) and was developed by Palazzo *et al.* (2014):

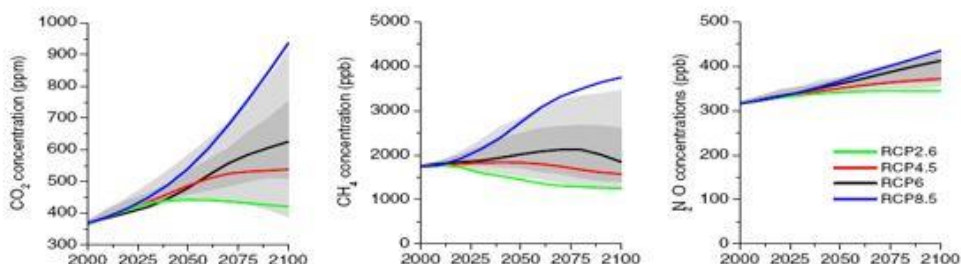
- ✓ Cash, Control, and Calories: This scenario is about short-term priorities with state actors as the dominant force in West Africa (SSP1);
- ✓ Self-Determination: In this scenario, state actors are dominant and long-term priorities prevail in West Africa (SSP2);
- ✓ Civil Society to the Rescue?: In this scenario, non-state actors are dominant and long-term issues have priority (SSP3);
- ✓ Save Yourself: In this scenario, non-state actors are the driving force and short-term priorities dominate in West Africa (SSP4).

These four SSPs were used to project the various dynamics of socio-economic parameters of the model. Crop and livestock prices were projected based on annual inflation rates. The inflation rates differ across SSPs and across countries of the West African Economic and Monetary Union (WAEMU) and non-WAEMU countries; (i) SSP1: 6% for WAEMU

countries and 12% for non WAEMU countries, (ii) SSP2: 2% for WAEMU countries and 8% for non WAEMU countries, (iii) SSP3: 4% for WAEMU countries and 10% for non-WAEMU countries, (iv) SSP4: 8% for WAEMU countries and 15% for non-WAEMU countries.

Climate scenarios used in this study were after Sylla, (2015) and was used to project future crop yields. Climate scenarios were based on a Regional Climate Model (RCM). A good representative of Coupled Model Inter-comparison Project, Phase 5 (CMIP5) models were selected and were dynamically downscaled using a good performing high resolution Regional Climate Model (RCM) over the West African region for two core Intergovernmental Panel on Climate Change (IPCC) RCPs, namely RCP4.5 which is a mid-level future greenhouse gas (GHG) forcing and RCP8.5 which is a higher level GHG forcing (Sylla, 2015). Figure 3 reports the concentration of the main GHGs in the atmosphere with respect to the RCPs from 2000 to 2100. Climate projections are mainly relative to precipitations and near surface temperature as well as evapotranspiration.

Figure 3. The Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways with the concentration of the main Greenhouse Gases (GHG) up to 2100



Source: Sylla (2015)

Bioeconomic model calibration

First of all, the economic-mathematical programming model was calibrated before being used for climate change impact simulation. The model calibration adopted consists of reproducing observed data for the baseline year of 2004. This means reproducing or obtaining the close value of observed land allocation for various crops per land use in 2004. For the calibration, we rely on the traditional PMP approach (Howitt, 1995), which is intensively used in the literature (e.g., Egbendewe-Mondzozo *et al.*, 2015; Egbendewe-Mondzozo *et al.*, 2011; Heckeley *et al.*, 2012). PMP is more popular used regarding regional bio-economic models (Howitt, 1995; Rohm & Dabbert, 2003). A strength of PMP calibration approach is that the model's solution is closer to observed reality (Kanellopoulos *et al.*, 2010). The usual three steps of the PMP approach are followed during the calibration procedure (Howitt, 1995; Kanellopoulos *et al.*, 2010). Firstly, a raw linear programming model is run to understand the model behavior

without calibration. We found that only vegetable and fruits (bananas, cassava, plantains, potatoes, sweet potatoes, and yam) are grown in all ACZs. Secondly, we rerun the simulation model, in which land use is constrained by the observed countries cropland for the years 2004 in order to replicate the observed crop land for this years at the country level. Finally, the shadow prices from the second step were used to calculate the coefficients of the marginal yield functions, which are then used to calibrate the model as a nonlinear quadratic optimization model under the assumption of a decreasing linear marginal yield. Following this calibration procedure, the model is able to predict cropland allocation at country level for the year 2004 with an average percentage deviation of 13.9%, which is within the acceptable range in modeling farmer behavior (Hazell & Norton, 1986; Howitt, 1995).

As in Egbendewe-Mondzozo *et al.* (2015), this study assumes a land penetration rate of plus and minus 2% each year to constrain cropland allocation dynamically in the simulations taking into account the fact that the total crop land use cannot base on greater than the available arable land. This allows us to adapt the static nature of the traditional PMP approach in a dynamic context with more realistic levels of acreage over time. It is worth noting that this approach does not allow the model to capture extreme climatic events in the short run. As many farmers in ECOWAS consume their own produce (Seo *et al.*, 2009), there may not be a significant shift in acreage patterns in the short run. Therefore, our calibration approach is consistent with observed rigidity in acreage expansion in the short run. A similar calibration approach is used for livestock production in ECOWAS.

Results and discussion

In this section, the underlying rationale for crop supply in response to climate change is investigated using ECOLAND. Given the long time horizon required for climate change impact assessments, the findings should not be interpreted as a projection or forecast rather as a probable outcome of an interaction between several uncertain driving forces (Medellin-Azuara *et al.*, 2011).

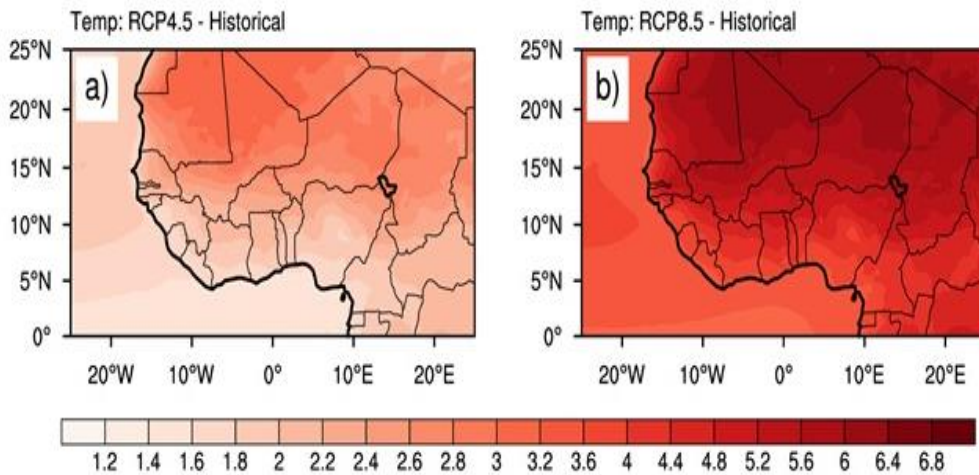
Climate Change in ECOWAS zone

Crop yields are predicted based on econometric models for two RCPs (RCP4.5 and RCP8.5). A regional warming is projected using a Regional Climate Models (RCM), which is a multi-model ensemble over all the ECOWAS region (Sylla, 2015)⁶. However, the warming differs across geographic units. The largest mean temperature increases are found in the North of the Gulf of Guinea, with a maximum over the Sahara desert. Smaller warming occurs over the orographic zones of Guinea, Cameroun Mountains, and Jos Plateau. The projected warming is substantially larger in RCP8.5 (the high-level GHG forcing scenario), which records a temperature increase ranging between 4K and 7K, than in RCP4.5 (the mid-level GHG forcing scenario) with an increase of about 1K to 3.6K (Figure 4). Regarding

⁶ Hundred and thirty years of simulations were performed up to 2100, and a differentiation between the future projection (RCP: 2070-2099) and the historical (present-day: 1976-2005) experiments is made in the computations of climate change signal (Sylla, 2015). The historical daily climate data covers the period 1970-2005, while the data are projected from 2006 to 2100.

Diurnal Temperature Range (DTR), which is the range between daytime and nighttime temperatures, RCP4.5 displays positive changes in all ECOWAS countries, and the maxima occur in Senegal, Northern Mali, and Niger (Sylla, 2015). However, negative changes are predicted for Southern Ghana, Cote d'Ivoire, Liberia, and Sierra Leone and more considerable increases in DTR is predicted with RCP8.5.

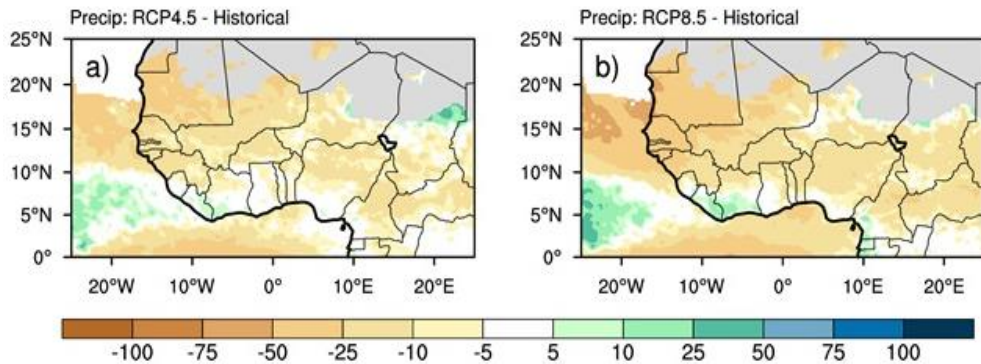
Figure 4. Projected changes (Future minus Historical) in mean seasonal temperature (in K or °C) for the ensemble of RCMs and for RCP4.5 and RCP8.5



Source: Sylla (2015)

Projected seasonal mean precipitations are found to reduce substantially in ECOWAS region for both RCPs, except in Southern Cote d'Ivoire and Sierra Leone (Sylla, 2015). However, the decrease rate differs across RCPs; the decrease rates range between 5% and 25% for the RCP4.5 (moderate climate change) and exceed 50% for the RCP8.5 (harsh climate change) compared to the historical records (Figure 5). Senegal, Guinea, and Mali are projected to experience the largest decrease in precipitations. Moreover, the length of the dry spell and the occurrence of the very heavy precipitation events are projected to substantially increase in both RCPs, with the largest increase in RCP8.5, while the wet spell length is projected to have a dipole pattern with a decrease in the Gulf of Guinea countries and increase in the Sahel.

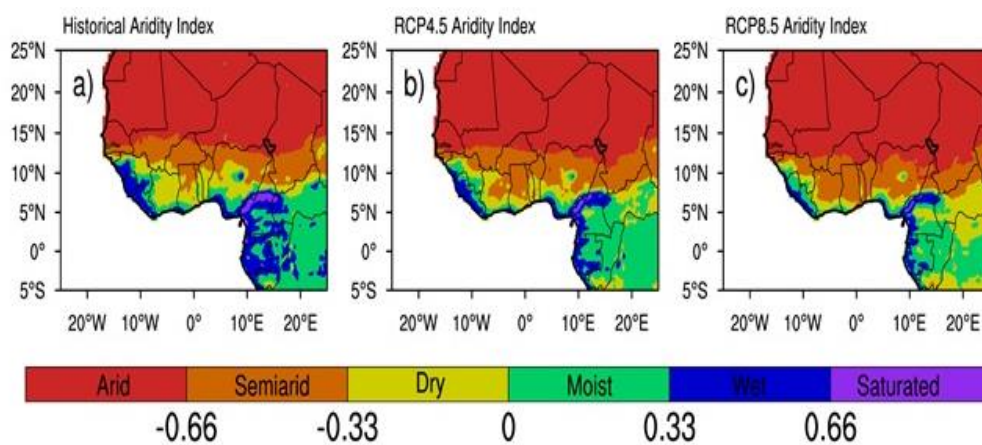
Figure 5. Projected changes (Future minus Historical) in mean seasonal precipitation (in %) for the ensembles of RCMs under RCP4.5 and RCP8.5



Source: Sylla (2015)

Regarding aridity, both RCPs exhibit in Northern Sahel and the Sahara desert a prevalent arid climate type, a southward shift of the semi-arid band located over the Sahel, and for the orographic areas and for the Gulf of Guinea coastlines, less extensive wet and moist climates (Sylla, 2015). Sahel countries will experience an increase in arid areas coverage, while for the countries of the Gulf of Guinea semi-arid conditions gain more areal extent (Figure 6). Overall, a shift towards more semi-arid and arid regimes is projected by both scenarios for the whole ECOWAS region, and these shifts are generally more pronounced in the case of RCP8.5 (Sylla, 2015).

Figure 6. Distribution of aridity index for the ensemble of RCMs during the Historical and the Future periods and for RCP4.5 and RCP8.5



Source: Sylla (2015)

Table 2. Acreage and production for 2004

	Acreage (1000 ha)							Production (1000 tons)						
	Paddy rice	Cereals	Vegetable and fruits	Oil seeds	Sugarcane	Cotton	Cocoa, coffee, and sesame	Paddy rice	Cereals	Vegetable and fruits	Oil seeds	Sugarcane	Cotton	Cocoa, coffee, and sesame
Benin	24.8	940.2	412.9	473.0	1.9	116.1	14.6	41.8	1014.0	4131.3	373.1	53.7	103.5	7.1
Burkina Faso	49.5	2959.8	19.9	336.6	3.6	14.1	1.5	86.0	2859.3	184.6	247.0	307.4	12.9	0.7
Cote d'Ivoire	341.0	383.7	1290.5	499.2	23.0	257.6	1063.1	552.5	556.1	11094.5	419.5	1372.3	199.6	504.2
Gambia	5.2	173.4	2.7	47.4		1.4	0.7	11.7	165.1	25.4	42.8		1.2	0.3
Ghana	119.4	767.2	1457.7	476.7	5.5	25.0	850.0	185.8	935.5	13000.8	414.6	408.3	20.3	399.5
Guinea	691.1	83.6	342.9	191.2	5.2	31.9	64.7	1040.7	110.4	2554.4	170.2	295.8	32.5	31.8
Guinea Bissau	65.0	61.9	16.3	154.3	0.2	4.1		107.5	83.6	158.5	133.4	7.8	3.6	
Liberia	47.1	6.9	109.6	5.5	0.1		10.0	62.5	8.7	717.8	4.7	7.3		4.5
Mali	96.7	2800.0	10.9	550.6	4.5	38.7	0.6	170.4	2681.0	110.1	350.3	373.8	35.0	0.3
Niger	23.4	7364.2	10.7	3090.1	3.8	10.0		43.7	6503.1	210.9	1834.3	325.0	9.7	
Nigeria	2348.0	12772.1	8008.0	6962.0	43.0	632.0	1230.6	3734.9	14608.6	73628.7	5971.7	4746.8	505.6	581.1
Senegal	81.5	890.9	62.1	589.0	7.1	43.6	1.2	184.4	807.0	551.9	367.2	662.9	39.2	0.6
Sierra Leone	452.8	67.5	312.7	120.0	1.0		47.4	556.0	84.7	2189.9	99.3	51.1		22.5
Togo	32.3	321.3	176.1	219.4	0.9	117.7	69.9	51.2	361.7	1594.2	194.0	49.2	94.2	34.3

Cropland allocation and production without climate change

As previously mentioned, the calibrated model is able to predict crop acreage of 2004 at country level with an average percentage deviation of 13.9%. These predicted cropland allocations and crop productions are reported in Table 2. It appears that acreage and productions differ across countries, showing the disparities in agricultural conditions on the ground level. Three groups of crops are not produced by certain countries and these are sugarcane in The Gambia (Sowe *et al.*, 2015), cotton in Liberia and Sierra Leone (Rhodes *et al.*, 2015) and cocoa, coffee and sesame in the Guinea-Bissau, and Niger (Cassamá *et al.*, 2015; Maman *et al.*, 2015).

Simulations without climate change are conducted to understand agricultural production paths under different socio-economic scenarios in the absence of climate change in the zone, thereby defining baseline scenarios against which the impact of climate change could be estimated. The findings show that acreage and production have an increasing trend over years for all crops. Paddy rice acreage and production follow the same patterns across all SSPs. However, they are almost 35% lower during the second half of the century than the first half in Senegal. Unlike paddy rice, cereals acreage and production exhibit heterogeneities across SSPs. Acreage and production are lower under SSP2 than other SSPs for some countries such as Burkina Faso, Mali, Niger, Nigeria, and Senegal during all the century, and Benin, The Gambia, Ghana, and Togo from 2090 to 2100. In 2100, cereals acreage and production are lower in Benin, Burkina Faso, The Gambia, Mali, Niger, Nigeria, and Senegal (percentage ranging from 9.28% in Benin to 185% in Senegal in terms of acreage) under the socio-economic conditions prevailing under SSP2 than those prevailing under SSP1. Vegetable, fruits, sugarcane, cocoa, coffee, and sesame acreage and production do not exhibit any

heterogeneities across SSPs. Although oilseeds, and cotton acreage and production follow the same patterns for all countries under SSPs 1, 3, and 4, they differ substantially under SSP2. Indeed, oilseeds, and cotton acreage and production are lower under SSP2 than SSP1 for countries such as Burkina Faso, Mali, Niger, Nigeria, and Senegal.

Climate changes implications in terms of cropland allocation

The changes in land use patterns for each climate scenario are analyzed across SSPs.

Paddy rice acreage

The distribution of paddy rice acreage follows the same patterns across SSPs under RCP4.5 and RCP8.5 (Tables 3 and 4). The moderate climate change impact negatively the paddy rice acreage from 2060 to the end of the century for all countries in the sub-region. However, countries are unevenly affected. Some countries as Rep. of Benin, Burkina Faso, and Mali will register a decrease in paddy rice acreage by 8.5%, 3.5%, and 6.8% respectively in 2080, whilst other countries such as The Gambia, Guinea Bissau, and Niger will not experience any change. The impact of climate change on paddy rice acreage is also unevenly distributed among countries under the harsh climate change. Indeed, countries such as Rep. of Benin, Burkina Faso, The Gambia, Guinea-Bissau, Mali, Niger, and Senegal do not experience any change in paddy rice acreage under the harsh climate change. Although other countries start experiencing the negative impacts of the hard climate change from 2070, these impacts become positive at the end of the century.

It is worth mentioning that the impacts of climate change on paddy rice acreage are higher under moderate climate change compared to the harsh climate change. It is important also to note that climate change impacts on paddy rice acreage vary across ACZs within countries. For example, the paddy rice acreage increases for loamy soils in some ACZs such ACZ15 (22.26% increase) by 2090 under moderate climate change and socio-economic conditions defined by SSP1. Under harsh climate change, negative changes in paddy rice acreage are observed in loamy soils for ACZ 3, whilst positive changes are observed in loamy soils for ACZ 15.

Table 3. Impact of climate change on paddy rice acreage under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	0.0	0.0	0.0	-8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-8.5	0.0	0.0	
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	-3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.5	0.0	0.0	
Cote d'Ivoire	0.0	0.0	0.0	0.0	-0.3	-1.9	-46.9	-2.1	-1.1	0.0	0.0	0.0	0.0	-0.3	-1.9	-46.9	-2.1	-1.1	
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ghana	0.0	0.0	0.0	0.0	-1.4	-7.5	-12.4	-10.2	-5.7	0.0	0.0	0.0	0.0	-1.4	-7.5	-12.4	-10.2	-5.7	
Guinea	0.0	0.0	0.0	0.0	-0.4	-2.2	-5.7	4.0	-1.8	0.0	0.0	0.0	0.0	-0.4	-2.2	-5.7	4.0	-1.8	
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Liberia	0.0	0.0	0.0	0.0	-1.7	-9.1	-10.6	-1.6	-8.6	0.0	0.0	0.0	0.0	-1.7	-9.1	-10.6	-1.6	-8.6	
Mali	0.0	0.0	0.0	0.0	0.0	0.0	-6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.8	0.0	0.0	
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Nigeria	0.0	-1.0	0.0	0.0	-1.6	-10.9	-36.2	-17.6	-9.7	0.0	-1.0	0.0	0.0	-1.6	-10.9	-36.2	-17.6	-9.7	
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sierra Leone	0.0	0.0	0.0	0.0	-3.0	-17.0	-22.2	-28.6	-20.3	0.0	0.0	0.0	0.0	-3.0	-17.0	-22.2	-28.6	-20.3	
Togo	0.0	0.0	0.0	0.0	0.0	0.0	-13.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-13.7	2.7	0.0	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	0.0	0.0	0.0	-8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-8.5	0.0	0.0	
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	-3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.5	0.0	0.0	
Cote d'Ivoire	0.0	0.0	0.0	0.0	-0.3	-1.9	-46.9	-2.1	-1.1	0.0	0.0	0.0	0.0	-0.3	-1.9	-46.9	-2.1	-1.1	
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ghana	0.0	0.0	0.0	0.0	-1.4	-7.5	-12.4	-10.2	-5.7	0.0	0.0	0.0	0.0	-1.4	-7.5	-12.4	-10.2	-5.7	
Guinea	0.0	0.0	0.0	0.0	-0.4	-2.2	-5.7	4.0	-1.8	0.0	0.0	0.0	0.0	-0.4	-2.2	-5.7	4.0	-1.8	
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Liberia	0.0	0.0	0.0	0.0	-1.7	-9.1	-10.6	-1.6	-8.6	0.0	0.0	0.0	0.0	-1.7	-9.1	-10.6	-1.6	-8.6	
Mali	0.0	0.0	0.0	0.0	0.0	0.0	-6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.8	0.0	0.0	
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Nigeria	0.0	-1.0	0.0	0.0	-1.6	-10.9	-36.2	-17.6	-9.7	0.0	-1.0	0.0	0.0	-1.6	-10.9	-36.2	-17.6	-9.7	
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sierra Leone	0.0	0.0	0.0	0.0	-3.0	-17.0	-22.2	-28.6	-20.3	0.0	0.0	0.0	0.0	-3.0	-17.0	-22.2	-28.6	-20.3	
Togo	0.0	0.0	0.0	0.0	0.0	0.0	-13.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-13.7	2.7	0.0	

Table 4. Impact of climate change on paddy rice acreage under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	-1.9	-3.8	0.1	2.6	0.0	0.0	0.0	0.0	0.0	-1.9	-3.8	0.1	2.6
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	-7.5	-8.4	-10.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.5	-8.4	-10.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	-2.2	-3.7	5.9	11.6	0.0	0.0	0.0	0.0	0.0	-2.2	-3.7	5.9	11.6
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	-9.1	-10.2	-1.6	17.2	0.0	0.0	0.0	0.0	0.0	-9.1	-10.2	-1.6	17.2
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	-10.9	-15.0	-14.9	0.2	0.0	0.0	0.0	0.0	0.0	-10.9	-15.0	-14.9	0.2
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	-17.0	-22.1	-28.6	3.7	0.0	0.0	0.0	0.0	0.0	-17.0	-22.1	-28.6	3.7
Togo	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	4.3	4.6	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	4.3	4.6
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	-1.9	-3.8	0.1	2.6	0.0	0.0	0.0	0.0	0.0	-1.9	-3.8	0.1	2.6
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	-7.5	-8.4	-10.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.5	-8.4	-10.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	-2.2	-3.7	5.9	11.6	0.0	0.0	0.0	0.0	0.0	-2.2	-3.7	5.9	11.6
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	-9.1	-10.2	-1.6	17.2	0.0	0.0	0.0	0.0	0.0	-9.1	-10.2	-1.6	17.2
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	-10.9	-15.0	-14.9	0.2	0.0	0.0	0.0	0.0	0.0	-10.9	-15.0	-14.9	0.2
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	-17.0	-22.1	-28.6	3.7	0.0	0.0	0.0	0.0	0.0	-17.0	-22.1	-28.6	3.7
Togo	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	4.3	4.6	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	4.3	4.6

Maize, sorghum, and millet acreage

The impact of climate change on maize, sorghum, and millet acreage follow the same patterns across SSPs, either for RCP4.5 or RCP8.5 (Tables 5, and 6). From 2020 to 2050, except the year 2050, climate change does not have a significant impact on cereal acreage in almost all countries of the ECOWAS, except for Mali, Niger, Nigeria and Senegal where we can observe an increase in cereal acreage under SSP1, 2 and 3 in 2020. After 2050 until the end of the century, climate change leads to a decrease in cropland allocated to maize, sorghum, and millet in almost all countries in ECOWAS, except Niger and The Gambia, where an increase in land allocated to these crops was observed. Results further showed that some countries such as Rep. of Benin, Guinea, Guinea-Bissau and Sierra Leone will register a decrease of more than 50% of the land allocated to cereal production by the end of the century irrespective of climate and socio-economic scenarios. A decrease of less than 10% in land allocated to cereal production was also observed in Burkina Faso, Gambia, Ghana and Nigeria by the end of century regardless of climate and socio-economic scenarios. In general, the difference of the distributions of climate change impacts on cereal acreage among countries of the ECOWAS under different climate and socio-economic scenarios is not apparent. Land under maize, sorghum, and millet production is differently impacted by climate change across ACZs. Indeed, a positive impact is observed in some ACSZs (e.g., in ACZ 20 for loamy soils and in ACZ 22 for loamy and sandy soils), whilst negative impact is found in another ACZs (e.g., in ACZs 32 and 34 for clay soils). These observed climate change impacts on cereal acreage at ACZ levels depend on SSPs.

Table 5. Impact of climate change on cereal acreage under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.2	-5.6	-26.7	-44.8	-50.6	0.0	-1.3	0.0	0.0	0.2	-5.6	-26.7	-50.6	-61.8
Burkina Faso	0.3	0.0	0.0	0.0	0.7	0.2	-0.1	-0.2	0.3	2.9	-18.0	0.0	0.0	0.7	-0.1	0.3	7.2	1.8
Cote d'Ivoire	0.0	0.0	0.0	2.9	26.0	-22.4	-7.5	-14.7	0.0	0.0	0.0	0.0	2.9	26.0	-22.4	-7.5	-14.7	0.0
Gambia	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	-20.3	0.0	0.1	0.2	0.1	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	-8.8	-7.5	-4.5	-4.1	-5.2	0.0	0.0	0.0	0.0	-8.8	-7.5	-4.5	-4.1	-5.5
Guinea	0.0	0.0	0.0	0.6	-7.3	-1.2	-0.3	-88.3	0.0	0.0	0.0	0.0	0.6	-7.3	-1.2	-0.3	-88.3	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6
Liberia	0.0	0.0	0.0	0.0	-38.5	0.0	0.0	-94.5	0.0	0.0	0.0	0.0	0.0	-38.5	0.0	0.0	-94.5	0.0
Mali	3.2	0.0	0.0	0.0	5.7	2.0	-0.4	-0.4	3.9	11.4	-15.0	0.0	0.0	4.0	-0.4	3.5	29.5	14.0
Niger	31.3	0.0	0.0	0.0	87.2	3.8	0.0	0.0	8.1	35.7	-5.3	0.0	0.0	5.8	0.0	6.1	78.6	34.4
Nigeria	0.6	0.0	0.0	0.8	3.0	0.4	-1.1	-1.1	1.5	2.3	-5.6	0.0	0.8	3.3	-0.9	0.8	8.7	3.2
Senegal	0.4	0.0	0.0	0.0	2.6	11.9	-0.1	-0.1	20.4	14.8	-29.7	0.0	0.0	20.7	-0.1	21.7	69.3	89.7
Sierra Leone	0.0	0.0	0.0	0.0	-79.3	-19.1	-5.7	-71.1	0.0	0.0	0.0	0.0	0.0	-79.3	-19.1	-5.7	-71.1	0.0
Togo	0.0	0.0	0.0	0.1	0.8	-10.7	-21.3	-32.5	-38.1	0.0	0.0	0.0	0.1	0.8	-10.7	-21.3	-32.5	-38.2
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.2	-5.6	-26.7	-44.8	-50.6	0.0	0.0	0.0	0.0	0.2	-5.6	-26.7	-44.8	-50.6
Burkina Faso	0.1	0.0	0.0	0.0	0.7	0.2	-0.1	-0.2	0.3	0.0	0.0	0.0	0.0	0.7	0.2	-0.1	0.3	0.3
Cote d'Ivoire	0.0	0.0	0.0	2.9	26.0	-22.4	-7.5	-14.7	0.0	0.0	0.0	0.0	2.9	26.0	-22.4	-7.5	-14.7	0.0
Gambia	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	-8.8	-7.5	-4.5	-4.1	-5.2	0.0	0.0	0.0	0.0	-8.8	-7.5	-4.5	-4.1	-5.2
Guinea	0.0	0.0	0.0	0.6	-7.3	-1.2	-0.3	-88.3	0.0	0.0	0.0	0.0	0.6	-7.3	-1.2	-0.3	-88.3	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6
Liberia	0.0	0.0	0.0	0.0	-38.5	0.0	0.0	-94.5	0.0	0.0	0.0	0.0	0.0	-38.5	0.0	0.0	-94.5	0.0
Mali	3.1	0.0	0.0	0.0	5.7	2.0	-0.4	-0.4	3.9	0.0	0.0	0.0	0.0	5.7	2.0	-0.4	3.4	3.9
Niger	31.9	0.0	0.0	0.0	87.2	3.8	0.0	0.0	8.1	0.0	0.0	0.0	0.0	87.2	3.8	0.0	6.8	8.1
Nigeria	-0.1	0.0	0.0	0.8	3.0	0.4	-1.1	-1.1	1.5	0.0	0.0	0.0	0.8	3.0	0.4	-1.1	1.2	1.5
Senegal	-0.9	0.0	0.0	0.0	2.6	11.9	-0.1	-0.1	20.4	0.0	0.0	0.0	0.0	2.6	11.9	-0.1	18.4	20.4
Sierra Leone	0.0	0.0	0.0	0.0	-79.3	-19.1	-5.7	-71.1	0.0	0.0	0.0	0.0	0.0	-79.3	-19.1	-5.7	-71.1	0.0
Togo	0.0	0.0	0.0	0.1	0.8	-10.7	-21.3	-32.5	-38.1	0.0	0.0	0.0	0.1	0.8	-10.7	-21.3	-32.5	-38.1

Table 6. Impact of climate change on cereal acreage under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100		
Benin	0.0	0.0	0.0	0.1	-3.5	-5.6	-26.7	-44.8	-50.4	0.0	0.0	0.0	0.1	-3.5	-5.6	-26.7	-50.6	-61.8		
Burkina Faso	0.3	0.0	0.0	0.3	0.6	-0.1	-0.1	-0.2	0.9	2.9	0.0	0.0	0.3	0.5	-0.1	-0.1	7.2	-0.2		
Cote d'Ivoire	0.0	0.0	0.0	2.9	-31.9	-22.4	-7.9	-14.7	-18.3	0.0	0.0	0.0	2.9	-31.9	-22.4	-7.9	-14.7	-18.3		
Gambia	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	-1.6		
Ghana	0.0	0.0	0.0	0.0	-10.6	-7.5	-4.5	-4.1	-5.2	0.0	0.0	0.0	0.0	-10.6	-7.5	-4.5	-4.1	-5.5		
Guinea	0.0	0.0	0.0	0.6	-15.7	-1.2	-3.8	-88.3	-92.0	0.0	0.0	0.0	0.6	-15.7	-1.2	-3.8	-88.3	-92.0		
Guinea Bissau	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6		
Liberia	0.0	0.0	0.0	0.0	-38.5	0.0	-3.9	-94.5	-96.3	0.0	0.0	0.0	0.0	-38.5	0.0	-3.9	-94.5	-96.3		
Mali	3.3	0.0	0.0	0.8	5.3	-0.3	-0.4	-0.4	5.6	11.4	0.0	0.0	0.9	3.5	-0.4	-0.4	29.5	10.0		
Niger	32.3	0.0	0.0	1.0	87.2	0.0	0.0	0.0	11.9	35.7	0.0	0.0	1.4	5.8	0.0	0.0	78.6	29.0		
Nigeria	0.6	0.0	0.0	2.3	0.2	-1.7	-1.1	-1.1	5.9	2.3	0.0	0.0	2.4	0.2	-1.8	-1.2	8.7	1.8		
Senegal	0.4	0.0	0.0	1.9	2.6	-0.1	-0.1	-0.1	24.3	14.8	0.0	0.0	2.8	20.6	-0.1	-0.1	69.3	76.4		
Sierra Leone	0.0	0.0	0.0	0.0	-79.3	-19.1	-8.2	-71.1	-78.8	0.0	0.0	0.0	0.0	-79.3	-19.1	-8.2	-71.1	-78.8		
Togo	0.0	0.0	0.0	0.1	-8.2	-10.7	-21.3	-32.5	-39.1	0.0	0.0	0.0	0.1	-8.2	-10.7	-21.3	-32.5	-39.1		
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100		
Benin	0.0	0.0	0.0	0.1	-3.5	-5.6	-26.7	-44.8	-50.4	0.0	0.0	0.0	0.1	-3.5	-5.6	-26.7	-44.8	-50.4		
Burkina Faso	0.3	0.0	0.0	0.3	0.6	-0.1	-0.1	-0.2	0.9	0.0	0.0	0.0	0.3	0.6	0.2	-0.1	-0.2	0.9		
Cote d'Ivoire	0.0	0.0	0.0	2.9	-31.9	-22.4	-7.9	-14.7	-18.3	0.0	0.0	0.0	2.9	-31.9	-22.4	-7.9	-14.7	-18.3		
Gambia	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1		
Ghana	0.0	0.0	0.0	0.0	-10.6	-7.5	-4.5	-4.1	-5.2	0.0	0.0	0.0	0.0	-10.6	-7.5	-4.5	-4.1	-5.2		
Guinea	0.0	0.0	0.0	0.6	-15.7	-1.2	-3.8	-88.3	-92.0	0.0	0.0	0.0	0.6	-15.7	-1.2	-3.8	-88.3	-92.0		
Guinea Bissau	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6	0.0	0.0	0.0	0.0	-14.4	-11.0	-29.2	-51.1	-60.6		
Liberia	0.0	0.0	0.0	0.0	-38.5	0.0	-3.9	-94.5	-96.3	0.0	0.0	0.0	0.0	-38.5	0.0	-3.9	-94.5	-96.3		
Mali	3.6	0.0	0.0	0.8	5.3	-0.3	-0.4	-0.4	5.6	0.0	0.0	0.0	0.8	5.3	2.0	-0.4	-0.4	5.6		
Niger	33.3	0.0	0.0	1.0	87.2	0.0	0.0	0.0	11.9	0.0	0.0	0.0	1.0	87.2	3.8	0.0	0.0	11.9		
Nigeria	0.6	0.0	0.0	2.3	0.2	-1.7	-1.1	-1.1	5.9	0.0	0.0	0.0	2.3	0.2	-0.4	-1.1	-1.1	5.9		
Senegal	0.5	0.0	0.0	1.9	2.6	-0.1	-0.1	-0.1	24.3	0.0	0.0	0.0	1.9	2.6	11.9	-0.1	-0.1	24.3		
Sierra Leone	0.0	0.0	0.0	0.0	-79.3	-19.1	-8.2	-71.1	-78.8	0.0	0.0	0.0	0.0	-79.3	-19.1	-8.2	-71.1	-78.8		
Togo	0.0	0.0	0.0	0.1	-8.2	-10.7	-21.3	-32.5	-39.1	0.0	0.0	0.0	0.1	-8.2	-10.7	-21.3	-32.5	-39.1		

Table 7. Impact of climate change on vegetable and fruits acreage under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-30.5	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 8. Impact of climate change on vegetable and fruits acreage under RCP8.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Vegetable and fruits acreage

Except for Senegal, climate change (both moderate and harsh) does not influence land allocated to vegetable and fruits production in all countries in ECOWAS regardless of socio-economic scenarios (Tables 7 and 8).

Oil seeds acreage

Both moderate and harsh climate change will affect oilseeds acreage positively or negatively depending on countries (Tables 9, and 10). Countries such as Rep. of Benin, Cote d'Ivoire, Ghana, Guinea, Nigeria and Togo will first experience a decrease, and by the end of the century an increase and eventually a decrease in land allocated to oilseeds production. Guinea-Bissau, Liberia and Sierra Leone will experience an increase in oilseeds acreage, whilst other countries (Burkina Faso, Gambia, Mali, Niger and Senegal) will face a decrease in land allocated to oilseeds production during the entire period of 2020-2100. These trends do not depend on climate and socio-economic scenarios. Except for Liberia and Sierra Leone, the impact of climate change on oilseeds acreage in countries in ECOWAS will vary between -73.2% and 61.2% for SSP1, SSP3, and SSP4, and between -90.2% and 85.4% for SSP2 under RCP4.5. The same pattern is observed under RCP8.5, except that countries experience a decrease in land allocated to oilseeds production earlier than under RCP4.5. It is worth mentioning that the impacts of climate change differ also across ACZs. For example, we observe positive impacts of climate change on oilseeds acreage in ACZ 13 for loamy soils, and in ACZ 27 for clay soils, while these impacts are negative in ACZs 20 and 22 for loamy soils under both moderate and harsh climate change coupled with socio-economic scenario SSP1.

Table 9. Impact of climate change on oil seeds acreage under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	0.0	-0.4	-0.3	15.3	47.2	84.7	0.0	0.0	0.0	0.0	-0.4	-0.3	15.3	47.5	85.4	
Burkina Faso	0.0	0.0	0.0	0.0	-5.8	-2.6	-0.3	0.0	-3.3	0.0	0.0	-0.1	0.0	-4.1	-4.0	-10.8	-1.8	-1.0	
Cote d'Ivoire	0.0	0.0	0.0	-1.6	-9.6	-39.0	-33.8	15.9	8.9	0.0	0.0	0.0	-1.6	-9.6	-39.0	-33.8	15.9	8.9	
Gambia	0.0	0.0	0.0	-0.6	-1.1	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-1.1	-0.7	0.0	0.0	0.0	
Ghana	0.0	0.0	0.0	-0.1	18.9	14.4	8.9	10.8	9.8	0.0	0.0	0.0	-0.1	18.9	14.4	8.9	10.8	9.8	
Guinea	0.0	0.0	0.0	-0.3	6.3	7.3	31.0	61.2	29.7	0.0	0.0	0.0	-0.3	6.3	7.3	31.0	61.2	29.7	
Guinea Bissau	0.0	0.0	0.0	0.0	5.8	3.4	6.0	15.9	26.0	0.0	0.0	0.0	0.0	5.8	3.4	6.0	15.9	26.0	
Liberia	0.0	0.0	0.0	0.0	213.7	559.1	861.7	1414.7	1200.4	0.0	0.0	0.0	0.0	213.7	559.1	861.7	1414.7	1200.4	
Mali	0.0	0.0	0.0	-0.1	-25.4	-10.7	-0.8	0.0	-20.7	0.0	0.0	-0.9	-0.1	-25.8	-45.1	-69.6	-57.0	-46.3	
Niger	0.0	0.0	0.0	0.0	-73.2	-2.4	0.0	0.0	-5.2	0.0	0.0	-2.4	0.0	-58.2	-85.3	-88.3	-90.2	-86.7	
Nigeria	0.0	0.0	0.0	-1.6	-5.5	-6.4	2.6	11.7	-0.2	0.0	0.0	-0.1	-1.8	-4.4	-7.6	-12.2	15.6	8.4	
Senegal	0.0	0.0	0.0	0.0	-3.7	-14.9	0.0	0.0	-32.6	0.0	0.0	0.0	0.0	-12.2	-3.2	-75.6	-6.2	-4.1	
Sierra Leone	0.0	0.0	0.0	0.0	160.0	285.3	375.0	500.5	300.1	0.0	0.0	0.0	0.0	160.0	285.3	375.0	500.5	300.1	
Togo	0.0	0.0	0.0	-0.1	-1.1	-2.1	6.2	24.2	40.9	0.0	0.0	0.0	-0.1	-1.1	-2.1	6.2	24.2	40.9	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	0.0	-0.4	-0.3	15.3	47.2	84.7	0.0	0.0	0.0	0.0	-0.4	-0.3	15.3	47.2	84.7	
Burkina Faso	0.0	0.0	0.0	0.0	-5.8	-2.6	-0.3	0.0	-3.3	0.0	0.0	0.0	0.0	-5.8	-2.6	-0.3	-2.9	-3.3	
Cote d'Ivoire	0.0	0.0	0.0	-1.6	-9.6	-39.0	-33.8	15.9	8.9	0.0	0.0	0.0	-1.6	-9.6	-39.0	-33.8	15.9	8.9	
Gambia	0.0	0.0	0.0	-0.6	-1.1	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-1.1	-0.7	0.0	0.0	0.0	
Ghana	0.0	0.0	0.0	-0.1	18.9	14.4	8.9	10.8	9.8	0.0	0.0	0.0	-0.1	18.9	14.4	8.9	10.8	9.8	
Guinea	0.0	0.0	0.0	-0.3	6.3	7.3	31.0	61.2	29.7	0.0	0.0	0.0	-0.3	6.3	7.3	31.0	61.2	29.7	
Guinea Bissau	0.0	0.0	0.0	0.0	5.8	3.4	6.0	15.9	26.0	0.0	0.0	0.0	0.0	5.8	3.4	6.0	15.9	26.0	
Liberia	0.0	0.0	0.0	0.0	213.7	559.1	861.7	1414.7	1200.4	0.0	0.0	0.0	0.0	213.7	559.1	861.7	1414.7	1200.4	
Mali	0.0	0.0	0.0	-0.1	-25.4	-10.7	-0.8	0.0	-20.7	0.0	0.0	0.0	-0.1	-25.4	-10.7	-0.8	-16.9	-20.7	
Niger	0.0	0.0	0.0	0.0	-73.2	-2.4	0.0	0.0	-5.2	0.0	0.0	0.0	0.0	-73.2	-2.4	0.0	-4.3	-5.2	
Nigeria	0.0	0.0	0.0	-1.6	-5.5	-6.4	2.6	11.7	-0.2	0.0	0.0	0.0	-1.6	-5.5	-6.4	2.6	6.7	-0.2	
Senegal	-0.3	0.0	0.0	0.0	-3.7	-14.9	0.0	0.0	-32.6	0.0	0.0	0.0	0.0	-3.7	-14.9	0.0	-26.4	-32.6	
Sierra Leone	0.0	0.0	0.0	0.0	160.0	285.3	375.0	500.5	300.1	0.0	0.0	0.0	0.0	160.0	285.3	375.0	500.5	300.1	
Togo	0.0	0.0	0.0	-0.1	-1.1	-2.1	6.2	24.2	40.9	0.0	0.0	0.0	-0.1	-1.1	-2.1	6.2	24.2	40.9	

Table 10. Impact of climate change on oil seeds acreage under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	-0.2	-0.2	-0.3	15.3	40.7	84.3	0.0	0.0	0.0	-0.2	-0.2	-0.3	15.3	41.0	85.4	
Burkina Faso	0.0	0.0	0.0	-2.3	-5.5	-0.5	-0.3	-0.1	-6.8	0.0	-7.8	-0.1	-2.5	-3.8	-4.0	-10.8	-1.9	-1.0	
Cote d'Ivoire	0.0	0.0	0.0	-1.6	12.2	-39.0	-33.8	-22.2	0.0	0.0	0.0	0.0	-1.6	12.2	-39.0	-33.8	-22.2	0.0	
Gambia	0.0	0.0	0.0	-0.9	-1.1	0.0	0.0	0.0	-0.8	0.0	0.0	0.0	-0.9	-1.1	0.0	0.0	0.0	0.0	
Ghana	0.0	0.0	0.0	-0.1	19.2	14.4	8.9	9.7	3.2	0.0	0.0	0.0	-0.1	19.2	14.4	8.9	9.7	3.2	
Guinea	0.0	0.0	0.0	-0.3	8.7	7.3	31.0	33.8	-0.1	0.0	0.0	0.0	-0.3	8.7	7.3	31.0	33.8	-0.1	
Guinea Bissau	0.0	0.0	0.0	0.0	5.8	3.4	6.0	13.8	26.0	0.0	0.0	0.0	0.0	5.8	3.4	6.0	13.8	26.0	
Liberia	0.0	0.0	0.0	0.0	165.2	559.1	861.7	1414.7	0.0	0.0	0.0	0.0	0.0	165.2	559.1	861.7	1414.7	0.0	
Mali	0.0	0.0	0.0	-3.5	-24.7	-1.2	-0.8	-0.3	-28.6	0.0	-34.3	-0.9	-5.9	-24.0	-45.1	-69.6	-58.5	-46.3	
Niger	0.0	0.0	0.0	-1.1	-73.2	0.0	0.0	0.0	-7.7	0.0	-24.4	-2.4	-1.3	-58.2	-85.3	-88.3	-90.2	-86.7	
Nigeria	0.0	0.0	0.0	-4.7	-1.1	-2.0	2.6	6.6	-15.5	0.0	-5.2	-0.1	-5.1	0.7	-5.6	-12.2	7.5	-0.1	
Senegal	0.0	0.0	0.0	-2.8	-3.7	0.0	0.0	0.0	-38.7	0.0	-50.1	0.0	-8.2	-12.2	-3.2	-75.6	-6.2	-4.1	
Sierra Leone	0.0	0.0	0.0	0.0	126.5	285.3	375.0	500.5	-0.4	0.0	0.0	0.0	0.0	126.5	285.3	375.0	500.5	-0.4	
Togo	0.0	0.0	0.0	-0.1	0.0	-2.1	6.2	19.8	40.9	0.0	0.0	0.0	-0.1	0.0	-2.1	6.2	19.8	40.9	

	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	-0.2	-0.2	-0.3	15.3	40.7	84.3	0.0	0.0	0.0	-0.2	-0.2	-0.3	15.3	40.7	84.3	
Burkina Faso	0.0	0.0	0.0	-2.3	-5.5	-0.5	-0.3	-0.1	-6.8	0.0	0.0	0.0	-2.3	-5.5	-2.6	-0.3	-0.1	-6.8	
Cote d'Ivoire	0.0	0.0	0.0	-1.6	12.2	-39.0	-33.8	-22.2	0.0	0.0	0.0	0.0	-1.6	12.2	-39.0	-33.8	-22.2	0.0	
Gambia	0.0	0.0	0.0	-0.9	-1.1	0.0	0.0	0.0	-0.8	0.0	0.0	0.0	-0.9	-1.1	0.0	0.0	0.0	-0.8	
Ghana	0.0	0.0	0.0	-0.1	19.2	14.4	8.9	9.7	3.2	0.0	0.0	0.0	-0.1	19.2	14.4	8.9	9.7	3.2	
Guinea	0.0	0.0	0.0	-0.3	8.7	7.3	31.0	33.8	-0.1	0.0	0.0	0.0	-0.3	8.7	7.3	31.0	33.8	-0.1	
Guinea Bissau	0.0	0.0	0.0	0.0	5.8	3.4	6.0	13.8	26.0	0.0	0.0	0.0	0.0	5.8	3.4	6.0	13.8	26.0	
Liberia	0.0	0.0	0.0	0.0	165.2	559.1	861.7	1414.7	0.0	0.0	0.0	0.0	0.0	165.2	559.1	861.7	1414.7	0.0	
Mali	0.0	0.0	0.0	-3.5	-24.7	-1.2	-0.8	-0.3	-28.6	0.0	0.0	0.0	-3.5	-24.7	-10.7	-0.8	-0.3	-28.6	
Niger	0.0	0.0	0.0	-1.1	-73.2	0.0	0.0	0.0	-7.7	0.0	0.0	0.0	-1.1	-73.2	-2.4	0.0	0.0	-7.7	
Nigeria	0.0	0.0	0.0	-4.7	-1.1	-2.0	2.6	6.6	-15.5	0.0	0.0	0.0	-4.7	-1.1	-4.7	2.6	6.6	-15.5	
Senegal	-0.3	0.0	-0.5	-2.8	-3.7	0.0	0.0	0.0	-38.7	0.0	0.0	0.0	-2.8	-3.7	-14.9	0.0	0.0	-38.7	
Sierra Leone	0.0	0.0	0.0	0.0	126.5	285.3	375.0	500.5	-0.4	0.0	0.0	0.0	0.0	126.5	285.3	375.0	500.5	-0.4	
Togo	0.0	0.0	0.0	-0.1	0.0	-2.1	6.2	19.8	40.9	0.0	0.0	0.0	-0.1	0.0	-2.1	6.2	19.8	40.9	

Sugarcane acreage

As reported in (Tables 11 and 12), climate change does not have any significant impact on the sugarcane acreage in most countries in the ECOWAS region such as Benin, Burkina-Faso, Cote d'Ivoire, Ghana, Liberia, Mali, Niger and Togo during the period of the study. However, countries like Guinea, Guinea-Bissau and Sierra Leone will, however, experience a sharp increase in land allocated to sugarcane production by the end of the century starting from 2070. In Guinea-Bissau, the increase will reach almost 70%, whilst it will be less than 10% in Guinea and Sierra Leone. These trends do not depend on climate and socio-economic scenarios. In some countries (e.g. Senegal and Nigeria), climate change impact on sugarcane acreage will exhibit different patterns under RCP4.5 and RCP8.5. Indeed, land allocated to sugarcane production in Nigeria will first increase, then decrease, and finally, increase by the end of the century under RCP4.5, whilst it will only increase by the end of the century under RCP8.5. Although sugarcane acreage in Senegal will not be affected by climate change under RCP4.5, it will experience a sharp decrease under RCP8.5 combined with SSP2. This decrease will reach almost 24% in 2090.

Cotton acreage

As reported in Tables 13 and 14, only Rep. of Benin, Ghana, Guinea, Guinea-Bissau, Senegal, Togo and The Gambia exhibited a constant trend in cotton acreage changes overall climate and socio-economic scenarios. Indeed, climate change will lead to an increase in cotton acreage by the end of the century for Benin, Ghana, and Togo; a U-shape form in cotton acreage for Senegal; an inverted U-shape for in cotton acreage for Guinea and Guinea Bissau and; a steady state in cotton acreage for Gambia. For other countries, the impact of climate change on cotton acreage depends on climate

and socio-economic scenarios. For example, Burkina-Faso will experience an increase in land allocated to cotton production by the end of the century under RCP4.5, whilst the climate impact will exhibit a U-shape form under RCP8.5 irrespective of socio-economic scenarios. Some countries like Mali, Niger, and Nigeria exhibiting a steady state or an increase in land allocated to cotton production under RCP4.5, will experience a climate change impact on cotton acreage with a U-shape form under RCP8.5, regardless of socio-economic scenarios. Only Senegal exhibited a decrease in cotton acreage at the beginning of the study period (less than 20% in 2020) under RCP4.5, whilst more countries including Senegal, Burkina Faso, Mali, Niger and Nigeria experience a decrease in cotton acreage under RCP8.5 during the same period. In general, the drop in land allocated to cotton production may reach 20%, 65%, and 28% respectively for SSP1, SSP2, and SSP3 under RCP4.5, whilst it may reach 48%, 65%, and 48% respectively for SSP1, SSP2, and SSP3 under RCP8.5. It is worth noticed that all countries exhibit an increase or a steady state in cotton acreage by the end of the century regardless of climate and socio-economic scenarios.

Land under cotton production also exhibited different patterns across ACZs for different climate and socio-economic scenarios. Indeed, the negative impact is observed in some ACZs (e.g., in ACZ 17 on sandy soils under RCP4.5 and SSP1, in ACZ 17 on sandy soils, and in ACZ 28 on loamy soils, which register a drop in cotton acreage of about 47.27% by 2020 under RCP8.5 and SSP1).

Table 11. Impact of climate change on sugarcane acreage under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	115.3	0.0	0.0	0.0	333.2	373.2	404.3	427.6	0.0	115.3	0.0	0.0	0.0	333.2	373.2	404.3	427.6
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	115.3	0.0	0.0	0.0	333.2	373.2	404.3	427.6	0.0	115.3	0.0	0.0	0.0	333.2	373.2	404.3	427.6
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 12. Impact of climate change on sugarcane acreage under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	333.2	373.2	404.3	0.0	0.0	0.0	0.0	0.0	0.0	333.2	373.2	404.3	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.8	0.0	-23.7	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8	0.0	0.0	0.0	0.0	0.0	67.5	70.4	72.4	73.8
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	333.2	373.2	404.3	0.0	0.0	0.0	0.0	0.0	0.0	333.2	373.2	404.3	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1	0.0	0.0	0.0	0.0	0.0	4.8	4.9	5.0	5.1
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 13. Impact of climate change on cotton acreage under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	43.8	229.0	175.5	83.2	0.0	0.0	0.0	0.0	0.0	43.8	229.0	175.5	83.2
Burkina Faso	0.0	0.0	0.0	0.0	0.0	45.9	59.0	31.4	31.9	0.0	-35.1	0.0	0.0	0.0	218.3	330.8	200.5	225.5
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	137.8	279.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	137.8	279.9	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	88.0	133.6	88.1	98.0	0.0	0.0	0.0	0.0	0.0	88.0	133.6	88.1	98.0
Guinea	0.0	0.0	0.0	0.0	0.0	57.0	119.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.0	119.8	0.0	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	11.2	250.7	197.4	0.0	0.0	0.0	0.0	0.0	0.0	11.2	250.7	197.4	0.0
Mali	0.0	0.0	0.0	0.0	0.0	51.7	71.2	28.4	29.0	0.0	-34.4	0.0	0.0	0.0	306.2	536.4	263.5	318.9
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-64.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	462.9	1023.8	75.1	81.7	0.0	-2.4	0.0	0.0	0.0	650.9	1696.7	148.1	197.8
Senegal	-20.0	0.0	0.0	0.0	0.0	1.3	1.4	1.4	2.0	-20.0	-25.2	0.0	0.0	0.0	5.4	6.8	8.3	9.9
Togo	0.0	0.0	0.0	0.0	0.0	30.3	49.5	45.6	45.0	0.0	0.0	0.0	0.0	0.0	30.3	49.5	45.6	45.0
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	43.8	229.0	175.5	83.2	0.0	0.0	0.0	0.0	0.0	43.8	229.0	175.5	83.2
Burkina Faso	0.0	0.0	0.0	0.0	0.0	45.9	59.0	31.4	31.9	0.0	0.0	0.0	0.0	0.0	45.9	59.0	31.4	31.9
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	137.8	279.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	137.8	279.9	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	88.0	133.6	88.1	98.0	0.0	0.0	0.0	0.0	0.0	88.0	133.6	88.1	98.0
Guinea	0.0	0.0	0.0	0.0	0.0	57.0	119.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.0	119.8	0.0	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	11.2	250.7	197.4	0.0	0.0	0.0	0.0	0.0	0.0	11.2	250.7	197.4	0.0
Mali	0.0	0.0	0.0	0.0	0.0	51.7	71.2	28.4	29.0	0.0	0.0	0.0	0.0	0.0	51.7	71.2	28.4	29.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	462.9	1023.8	75.1	81.7	0.0	0.0	0.0	0.0	0.0	462.9	1023.8	75.1	81.7
Senegal	-20.0	-27.4	0.0	0.0	0.0	1.3	1.4	1.4	2.0	0.0	0.0	0.0	0.0	0.0	1.3	1.4	1.4	2.0
Togo	0.0	0.0	0.0	0.0	0.0	30.3	49.5	45.6	45.0	0.0	0.0	0.0	0.0	0.0	30.3	49.5	45.6	45.0

Table 14. Impact of climate change on cotton acreage under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	28.3	43.8	224.4	235.6	83.2	0.0	0.0	0.0	0.0	28.3	43.8	224.4	235.6	83.2
Burkina Faso	-25.7	0.0	0.0	0.0	27.7	45.9	40.1	34.7	31.9	0.0	-35.1	0.0	0.0	108.1	218.3	224.6	221.9	225.5
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	137.8	93.5	39.9	0.0	0.0	0.0	0.0	0.0	0.0	137.8	93.5	39.9	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	54.2	88.0	95.5	98.1	98.0	0.0	0.0	0.0	0.0	54.2	88.0	95.5	98.1	98.0
Guinea	0.0	0.0	0.0	0.0	0.0	57.0	40.0	17.2	0.0	0.0	0.0	0.0	0.0	0.0	57.0	40.0	17.2	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	11.2	250.7	319.9	0.0	0.0	0.0	0.0	0.0	0.0	11.2	250.7	319.9	0.0
Mali	-25.2	0.0	0.0	0.0	24.8	51.7	42.2	33.5	29.0	0.0	-34.4	0.0	0.0	112.8	306.2	317.8	311.2	318.9
Niger	-47.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-64.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	-1.7	0.0	0.0	0.0	29.7	462.9	384.5	216.0	81.7	0.0	-2.4	0.0	0.0	37.7	650.9	637.2	425.9	197.8
Senegal	-31.8	0.0	0.0	0.0	1.2	1.3	1.4	1.4	2.0	-20.0	-25.2	0.0	0.0	4.6	5.4	6.8	8.4	9.9
Togo	0.0	0.0	0.0	0.0	24.0	30.3	44.5	51.1	45.0	0.0	0.0	0.0	0.0	24.0	30.3	44.5	51.1	45.0
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	28.3	43.8	224.4	235.6	83.2	0.0	0.0	0.0	0.0	28.3	43.8	224.4	235.6	83.2
Burkina Faso	-25.7	0.0	0.0	0.0	27.7	45.9	40.1	34.7	31.9	0.0	0.0	0.0	0.0	27.7	45.9	40.1	34.7	31.9
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	137.8	93.5	39.9	0.0	0.0	0.0	0.0	0.0	0.0	137.8	93.5	39.9	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	54.2	88.0	95.5	98.1	98.0	0.0	0.0	0.0	0.0	54.2	88.0	95.5	98.1	98.0
Guinea	0.0	0.0	0.0	0.0	0.0	57.0	40.0	17.2	0.0	0.0	0.0	0.0	0.0	0.0	57.0	40.0	17.2	0.0
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	11.2	250.7	319.9	0.0	0.0	0.0	0.0	0.0	0.0	11.2	250.7	319.9	0.0
Mali	-25.2	0.0	0.0	0.0	24.8	51.7	42.2	33.5	29.0	0.0	0.0	0.0	0.0	24.8	51.7	42.2	33.5	29.0
Niger	-47.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	-1.7	0.0	0.0	0.0	29.7	462.9	384.5	216.0	81.7	0.0	0.0	0.0	0.0	29.7	462.9	384.5	216.0	81.7
Senegal	-31.8	-27.4	0.0	0.0	1.2	1.3	1.4	1.4	2.0	0.0	0.0	0.0	0.0	1.2	1.3	1.4	1.4	2.0
Togo	0.0	0.0	0.0	0.0	24.0	30.3	44.5	51.1	45.0	0.0	0.0	0.0	0.0	24.0	30.3	44.5	51.1	45.0

Cocoa, coffee, and sesame acreage

As reported in Tables 15 and 16, both moderate and harsh climate changes do not affect land under cocoa, coffee, and sesame production regardless of socio-economic conditions.

Climate changes implications in terms of crop production

Except for rice, production of sugarcane and cotton should be interpreted as an indicator of production because it refers to a group of crops.

Paddy rice production

Except for Niger and Senegal, paddy rice production decreased in most of the years for all countries in ECOWAS region regardless of climate and socio-economic scenarios (Tables 17, and 18). These decreases range between 5-60 percent with an average of 11 percent under RCP4.5, and between 2-40 percent with an average of 8 percent under RCP8.5. Irrespective of socio-economic scenarios, it will register an increase in paddy rice production for all countries in ECOWAS, ranging between 0.1-9 percent (with an average of 4.5 percent) by 2050 under RCP4.5, and between 0.3-23 percent (with an average of 9.5 percent) by 2040, 2050 and 2060 under RCP8.5. Furthermore, countries like Niger and Senegal will experience an increase in paddy rice production almost every year of the study period, regardless of climate and socio-economic scenarios. However, the yearly distribution of these impacts will depend significantly on climate and socio-economic scenarios. For example, paddy rice production will increase in Niger during the period (i.e. between years 2010 and 2100) of study by 07-14.2 percent (with an average of 6.1 percent) under SSP1 and RCP4.5, and by 0.7-17.4 percent (with an average of 5.2 percent) under SSP2 and RCP4.5. As for paddy rice acreage, the impact of climate change on paddy rice production also exhibits heterogeneities across ACZs. For

example, ACZs 3 and 6 will experience an increase in paddy rice production from 2045 to 2060 in loamy soils under both moderate and harsh climate change coupled with SSP1.

Table 15. Impact of climate change on cocoa, coffee, and sesame acreage under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 16. Impact of climate change on cocoa, coffee, and sesame acreage under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 17. Impact of climate change on paddy rice production under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-3.7	-8.0	-1.3	5.3	12.5	-1.3	-23.3	-11.6	-7.3	-3.7	-8.0	-1.3	5.3	12.5	-1.3	-23.3	-11.6	-7.3
Burkina Faso	-1.2	-2.9	1.3	6.9	18.4	6.3	-11.8	-5.3	-0.7	-1.2	-2.9	1.3	6.9	18.4	6.3	-11.8	-5.3	-0.7
Cote d'Ivoire	-5.4	-6.7	-0.9	5.5	3.1	-10.7	-61.0	-16.0	-9.0	-5.4	-6.7	-0.9	5.5	3.1	-10.7	-61.0	-16.0	-9.0
Gambia	-5.0	-10.1	-5.5	0.1	12.3	-3.4	-19.1	-10.8	-7.9	-5.0	-10.1	-5.5	0.1	12.3	-3.4	-19.1	-10.8	-7.9
Ghana	-7.6	-8.1	-1.4	4.0	-2.9	-17.2	-31.4	-20.9	-13.1	-7.6	-8.1	-1.4	4.0	-2.9	-17.2	-31.4	-20.9	-13.1
Guinea	-11.5	-8.5	-1.8	3.6	-4.6	-18.3	-32.0	-14.0	-10.9	-11.5	-8.5	-1.8	3.6	-4.6	-18.3	-32.0	-14.0	-10.9
Guinea Bissau	-12.0	-11.9	-4.3	2.5	-7.0	-15.1	-24.7	-18.3	-13.9	-12.0	-11.9	-4.3	2.5	-7.0	-15.1	-24.7	-18.3	-13.9
Liberia	-14.0	-9.1	-2.9	1.7	-12.5	-27.7	-36.6	-17.4	-18.4	-14.0	-9.1	-2.9	1.7	-12.5	-27.7	-36.6	-17.4	-18.4
Mali	-0.3	-0.9	2.1	7.4	19.3	7.9	-12.7	-3.5	1.4	-0.3	-0.9	2.1	7.4	19.3	7.9	-12.7	-3.5	1.4
Niger	2.7	5.7	5.4	9.0	24.6	16.3	2.0	4.4	9.6	2.7	5.7	5.4	9.0	24.6	16.3	2.0	4.4	9.6
Nigeria	-7.4	-9.2	-1.3	4.9	0.9	-18.2	-50.9	-26.4	-15.3	-7.4	-9.2	-1.3	4.9	0.9	-18.2	-50.9	-26.4	-15.3
Senegal	2.6	0.7	1.5	5.4	14.2	9.0	-0.9	6.6	9.0	2.6	0.7	1.5	5.4	14.2	9.0	-0.9	6.6	9.0
Sierra Leone	-14.4	-10.9	-3.6	1.4	-15.9	-36.6	-47.5	-42.5	-32.2	-14.4	-10.9	-3.6	1.4	-15.9	-36.6	-47.5	-42.5	-32.2
Togo	-5.6	-7.2	-0.8	5.8	9.0	-4.9	-30.7	-10.0	-7.0	-5.6	-7.2	-0.8	5.8	9.0	-4.9	-30.7	-10.0	-7.0
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-3.7	-8.0	-1.3	5.3	12.5	-1.3	-23.3	-11.6	-7.3	-3.7	-8.0	-1.3	5.3	12.5	-1.3	-23.3	-11.6	-7.3
Burkina Faso	-1.2	-2.9	1.3	6.9	18.4	6.3	-11.8	-5.3	-0.7	-1.2	-2.9	1.3	6.9	18.4	6.3	-11.8	-5.3	-0.7
Cote d'Ivoire	-5.4	-6.7	-0.9	5.5	3.1	-10.7	-61.0	-16.0	-9.0	-5.4	-6.7	-0.9	5.5	3.1	-10.7	-61.0	-16.0	-9.0
Gambia	-5.0	-10.1	-5.5	0.1	12.3	-3.4	-19.1	-10.8	-7.9	-5.0	-10.1	-5.5	0.1	12.3	-3.4	-19.1	-10.8	-7.9
Ghana	-7.6	-8.1	-1.4	4.0	-2.9	-17.2	-31.4	-20.9	-13.1	-7.6	-8.1	-1.4	4.0	-2.9	-17.2	-31.4	-20.9	-13.1
Guinea	-11.5	-8.5	-1.8	3.6	-4.6	-18.3	-32.0	-14.0	-10.9	-11.5	-8.5	-1.8	3.6	-4.6	-18.3	-32.0	-14.0	-10.9
Guinea Bissau	-12.0	-11.9	-4.3	2.5	-7.0	-15.1	-24.7	-18.3	-13.9	-12.0	-11.9	-4.3	2.5	-7.0	-15.1	-24.7	-18.3	-13.9
Liberia	-14.0	-9.1	-2.9	1.7	-12.5	-27.7	-36.6	-17.4	-18.4	-14.0	-9.1	-2.9	1.7	-12.5	-27.7	-36.6	-17.4	-18.4
Mali	-0.3	-0.9	2.1	7.4	19.3	7.9	-12.7	-3.5	1.4	-0.3	-0.9	2.1	7.4	19.3	7.9	-12.7	-3.5	1.4
Niger	2.7	5.7	5.4	9.0	24.6	16.3	2.0	4.4	9.6	2.7	5.7	5.4	9.0	24.6	16.3	2.0	4.4	9.6
Nigeria	-7.4	-9.2	-1.3	4.9	0.9	-18.2	-50.9	-26.4	-15.3	-7.4	-9.2	-1.3	4.9	0.9	-18.2	-50.9	-26.4	-15.3
Senegal	2.6	0.7	1.5	5.4	14.2	9.0	-0.9	6.6	9.0	2.6	0.7	1.5	5.4	14.2	9.0	-0.9	6.6	9.0
Sierra Leone	-14.4	-10.9	-3.6	1.4	-15.9	-36.6	-47.5	-42.5	-32.2	-14.4	-10.9	-3.6	1.4	-15.9	-36.6	-47.5	-42.5	-32.2
Togo	-5.6	-7.2	-0.8	5.8	9.0	-4.9	-30.7	-10.0	-7.0	-5.6	-7.2	-0.8	5.8	9.0	-4.9	-30.7	-10.0	-7.0

Table 18. Impact of climate change on paddy rice production under RCP8.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-1.2	0.6	5.2	14.9	16.4	3.7	-14.6	-8.8	0.3	-1.2	0.6	5.2	14.9	16.4	3.7	-14.6	-8.8	0.3
Burkina Faso	0.2	1.4	4.6	12.6	20.2	10.0	-6.0	-0.2	7.7	0.2	1.4	4.6	12.6	20.2	10.0	-6.0	-0.2	7.7
Cote d'Ivoire	-3.6	-0.2	6.0	12.5	10.9	-1.4	-17.7	-8.7	-0.8	-3.6	-0.2	6.0	12.5	10.9	-1.4	-17.7	-8.7	-0.8
Gambia	-2.5	-4.7	0.3	5.0	13.8	-1.8	-15.4	-6.2	1.9	-2.5	-4.7	0.3	5.0	13.8	-1.8	-15.4	-6.2	1.9
Ghana	-4.7	-3.1	2.3	5.6	2.7	-12.7	-23.4	-18.1	-2.0	-4.7	-3.1	2.3	5.6	2.7	-12.7	-23.4	-18.1	-2.0
Guinea	-8.5	-0.2	5.0	10.1	6.1	-6.7	-20.0	-8.6	4.7	-8.5	-0.2	5.0	10.1	6.1	-6.7	-20.0	-8.6	4.7
Guinea Bissau	-6.7	-9.3	-2.2	-3.4	-4.6	-10.7	-15.6	-7.5	-1.0	-6.7	-9.3	-2.2	-3.4	-4.6	-10.7	-15.6	-7.5	-1.0
Liberia	-10.1	-1.4	2.9	4.4	-2.5	-18.2	-26.2	-12.7	12.4	-10.1	-1.4	2.9	4.4	-2.5	-18.2	-26.2	-12.7	12.4
Mali	0.6	1.3	4.5	11.3	20.7	11.7	-3.0	2.9	9.9	0.6	1.3	4.5	11.3	20.7	11.7	-3.0	2.9	9.9
Niger	2.1	0.7	3.3	6.6	23.5	18.6	8.3	14.3	19.3	2.1	0.7	3.3	6.6	23.5	18.6	8.3	14.3	19.3
Nigeria	-4.7	-1.6	4.4	9.6	7.6	-11.3	-26.5	-19.5	-1.2	-4.7	-1.6	4.4	9.6	7.6	-11.3	-26.5	-19.5	-1.2
Senegal	4.6	1.4	3.8	6.7	19.1	16.5	10.5	16.4	15.7	4.6	1.4	3.8	5.7	18.7	9.6	-1.9	5.8	12.2
Sierra Leone	-10.5	-5.1	0.7	0.2	-7.8	-30.4	-40.0	-39.0	-2.6	-10.5	-5.1	0.7	0.2	-7.8	-30.4	-40.0	-39.0	-2.6
Togo	-3.0	1.5	6.4	14.1	14.7	2.1	-15.3	-5.0	4.4	-3.0	1.5	6.4	14.1	14.7	2.1	-15.3	-5.0	4.4
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-1.2	0.6	5.2	14.9	16.4	3.7	-14.6	-8.8	0.3	-1.2	0.6	5.2	14.9	16.4	3.7	-14.6	-8.8	0.3
Burkina Faso	0.2	1.4	4.6	12.6	20.2	10.0	-6.0	-0.2	7.7	0.2	1.4	4.6	12.6	20.2	10.0	-6.0	-0.2	7.7
Cote d'Ivoire	-3.6	-0.2	6.0	12.5	10.9	-1.4	-17.7	-8.7	-0.8	-3.6	-0.2	6.0	12.5	10.9	-1.4	-17.7	-8.7	-0.8
Gambia	-2.5	-4.7	0.3	5.0	13.8	-1.8	-15.4	-6.2	1.9	-2.5	-4.7	0.3	5.0	13.8	-1.8	-15.4	-6.2	1.9
Ghana	-4.7	-3.1	2.3	5.6	2.7	-12.7	-23.4	-18.1	-2.0	-4.7	-3.1	2.3	5.6	2.7	-12.7	-23.4	-18.1	-2.0
Guinea	-8.5	-0.2	5.0	10.1	6.1	-6.7	-20.0	-8.6	4.7	-8.5	-0.2	5.0	10.1	6.1	-6.7	-20.0	-8.6	4.7
Guinea Bissau	-6.7	-9.3	-2.2	-3.4	-4.6	-10.7	-15.6	-7.5	-1.0	-6.7	-9.3	-2.2	-3.4	-4.6	-10.7	-15.6	-7.5	-1.0
Liberia	-10.1	-1.4	2.9	4.4	-2.5	-18.2	-26.2	-12.7	12.4	-10.1	-1.4	2.9	4.4	-2.5	-18.2	-26.2	-12.7	12.4
Mali	0.6	1.3	4.5	11.3	20.7	11.7	-3.0	2.9	9.9	0.6	1.3	4.5	11.3	20.7	11.7	-3.0	2.9	9.9
Niger	2.1	0.7	3.3	6.6	23.5	18.6	8.3	14.3	19.3	2.1	0.7	3.3	6.6	23.5	18.6	8.3	14.3	19.3
Nigeria	-4.7	-1.6	4.4	9.6	7.6	-11.3	-26.5	-19.5	-1.2	-4.7	-1.6	4.4	9.6	7.6	-11.3	-26.5	-19.5	-1.2
Senegal	4.6	1.4	3.8	6.7	19.1	16.5	10.5	16.4	15.7	4.6	1.4	3.8	5.7	18.7	9.6	-1.9	5.8	12.2
Sierra Leone	-10.5	-5.1	0.7	0.2	-7.8	-30.4	-40.0	-39.0	-2.6	-10.5	-5.1	0.7	0.2	-7.8	-30.4	-40.0	-39.0	-2.6
Togo	-3.0	1.5	6.4	14.1	14.7	2.1	-15.3	-5.0	4.4	-3.0	1.5	6.4	14.1	14.7	2.1	-15.3	-5.0	4.4

Maize, sorghum, and millet production

As reported in Tables 19 and 20, climate change will negatively affect the production of these cereals (i.e. maize, sorghum, and millet) regardless of climate and socio-economic scenarios. Although the negative impact of climate change on cereal production is significantly different between RCPs, it exhibits a similar pattern under SSPs. Indeed, cereal production will decrease by 0.3-95.8 percent (with an average of 19.5, 20.1, 19.5 and 19.4 percent respectively for SSP1, SSP2, SSP3, and SSP4) under RCP4.5, whilst it will decrease by 0.2-96.9 percent (with an average of 22.9, 23.0, 22.6, and 22.2 percent respectively for SSP1, SSP2, SSP3, and SSP4) under RCP8.5. However, climate change also has a positive impact on cereal production in some countries in ECOWAS. For example, Niger, and Senegal experience an increase in maize, sorghum, and millet production from 2020 to 2060 under harsh climate change regardless of socio-economic scenarios. During the first half of the century, Cote d'Ivoire, Guinea, Liberia, and Sierra Leone experience a higher drop in cereal production under RCP8.5 than under RCP4.5, whilst other countries are more negatively affected by moderate climate change than under harsh climate change. After the mid-century, all countries seem to be less negatively affected by moderate climate change than under harsh climate change.

The disparity in climate change impacts on cereal production is also observed across ACZs. Under SSP1, the production of maize, sorghum, and millet will benefit from moderate climate change on loamy soils in ACZ 15 from 2020 to 2050 and in ACZ 22 from 2050 to 2060, with an increase of about 743.39% by 2060. Furthermore, we will observe an increase (an average increase of about 731.13%) in maize, sorghum, and millet

production from 2050 to 2065 for sandy soils in ACZ 30 under the harsh climate change and SSP1.

Table 19. Impact of climate change on cereal production under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	-7.1	-5.4	-9.3	-5.0	-10.2	-28.8	-51.7	-61.7	-60.3	-7.1	-6.5	-9.3	-5.0	-10.2	-28.8	-51.7	-66.3	-69.4	
Burkina Faso	-6.1	-5.1	-9.9	-4.9	-3.6	-18.4	-27.9	-20.6	-9.0	-4.1	-21.3	-10.0	-5.1	-4.4	-19.6	-28.3	-15.9	-9.2	
Cote d'Ivoire	-5.4	-3.3	-5.8	-0.3	6.8	-44.4	-37.0	-36.0	-11.3	-5.4	-3.3	-5.8	-0.3	6.8	-44.4	-37.0	-36.0	-11.3	
Gambia	-6.2	-5.2	-10.0	-5.0	-4.4	-18.6	-27.8	-20.4	-9.3	-6.5	-23.6	-10.0	-5.0	-4.4	-18.6	-27.8	-20.9	-9.7	
Ghana	-7.4	-5.5	-9.1	-5.0	-20.2	-32.2	-37.1	-30.4	-18.4	-7.4	-5.5	-9.1	-5.0	-20.2	-32.2	-37.1	-30.5	-18.8	
Guinea	-1.4	1.6	-0.7	0.0	-18.6	-27.5	-28.5	-91.4	-3.9	-1.4	1.6	-0.7	0.0	-18.6	-27.5	-28.5	-91.4	-3.9	
Guinea Bissau	-6.0	-4.3	-6.5	-8.4	-34.1	-39.4	-54.1	-64.5	-67.8	-6.0	-4.3	-6.5	-8.4	-34.1	-39.4	-54.1	-64.5	-67.8	
Liberia	0.2	3.1	1.3	-0.5	-44.8	-26.4	-27.8	-95.8	-3.3	0.2	3.1	1.3	-0.5	-44.8	-26.4	-27.8	-95.8	-3.3	
Mali	-2.6	-4.3	-9.2	-4.2	3.1	-15.0	-26.8	-19.6	-5.1	4.4	-18.4	-9.8	-4.8	-1.1	-19.9	-26.1	1.6	0.9	
Niger	29.5	-1.7	-6.9	-2.7	93.3	-8.7	-22.5	-15.1	0.9	33.9	-8.0	-7.8	-3.6	6.9	-13.4	-18.2	54.1	27.5	
Nigeria	-5.9	-4.9	-9.3	-3.2	-3.7	-20.5	-30.7	-23.5	-9.3	-4.6	-9.6	-9.5	-3.3	-4.4	-22.6	-30.1	-17.0	-9.4	
Senegal	-2.7	-3.1	-8.0	-3.3	4.8	-1.5	-23.1	-15.8	12.3	11.1	-32.1	-9.0	-4.5	18.7	-16.7	-8.6	40.1	72.8	
Sierra Leone	-1.6	0.4	-0.8	-3.0	-82.1	-42.7	-33.5	-78.6	-4.8	-1.6	0.4	-0.8	-3.0	-82.1	-42.7	-33.5	-78.6	-4.8	
Togo	-8.2	-5.9	-10.0	-4.5	-9.7	-33.8	-49.0	-53.0	-48.1	-8.2	-5.9	-10.0	-4.5	-9.7	-33.8	-49.0	-53.0	-48.1	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	-7.1	-5.4	-9.3	-5.0	-10.2	-28.8	-51.7	-61.7	-60.3	-7.1	-5.4	-9.3	-5.0	-10.2	-28.8	-51.7	-61.7	-60.3	
Burkina Faso	-6.4	-5.1	-9.9	-4.9	-3.6	-18.4	-27.9	-20.6	-9.0	-6.1	-5.1	-9.9	-4.9	-3.6	-18.4	-27.9	-20.2	-9.0	
Cote d'Ivoire	-5.4	-3.3	-5.8	-0.3	6.8	-44.4	-37.0	-36.0	-11.3	-5.4	-3.3	-5.8	-0.3	6.8	-44.4	-37.0	-36.0	-11.3	
Gambia	-6.5	-5.2	-10.0	-5.0	-4.4	-18.6	-27.8	-20.4	-9.3	-6.2	-5.2	-10.0	-5.0	-4.4	-18.6	-27.8	-20.4	-9.3	
Ghana	-7.4	-5.5	-9.1	-5.0	-20.2	-32.2	-37.1	-30.4	-18.4	-7.4	-5.5	-9.1	-5.0	-20.2	-32.2	-37.1	-30.4	-18.4	
Guinea	-1.4	1.6	-0.7	0.0	-18.6	-27.5	-28.5	-91.4	-3.9	-1.4	1.6	-0.7	0.0	-18.6	-27.5	-28.5	-91.4	-3.9	
Guinea Bissau	-6.0	-4.3	-6.5	-8.4	-34.1	-39.4	-54.1	-64.5	-67.8	-6.0	-4.3	-6.5	-8.4	-34.1	-39.4	-54.1	-64.5	-67.8	
Liberia	0.2	3.1	1.3	-0.5	-44.8	-26.4	-27.8	-95.8	-3.3	0.2	3.1	1.3	-0.5	-44.8	-26.4	-27.8	-95.8	-3.3	
Mali	-2.8	-4.3	-9.2	-4.2	3.1	-15.0	-26.8	-19.6	-5.1	-4.6	-4.3	-9.2	-4.2	3.1	-15.0	-26.8	-16.3	-5.1	
Niger	30.1	-1.7	-6.9	-2.7	93.3	-8.7	-22.5	-15.1	0.9	0.5	-1.7	-6.9	-2.7	93.3	-8.7	-22.5	-8.9	0.9	
Nigeria	-6.5	-4.9	-9.3	-3.2	-3.7	-20.5	-30.7	-23.5	-9.3	-6.1	-4.9	-9.3	-3.2	-3.7	-20.5	-30.7	-21.7	-9.3	
Senegal	-3.6	-3.1	-8.0	-3.3	4.8	-1.5	-23.1	-15.8	12.3	-2.2	-3.1	-8.0	-3.3	4.8	-1.5	-23.1	0.9	12.3	
Sierra Leone	-1.6	0.4	-0.8	-3.0	-82.1	-42.7	-33.5	-78.6	-4.8	-1.6	0.4	-0.8	-3.0	-82.1	-42.7	-33.5	-78.6	-4.8	
Togo	-8.2	-5.9	-10.0	-4.5	-9.7	-33.8	-49.0	-53.0	-48.1	-8.2	-5.9	-10.0	-4.5	-9.7	-33.8	-49.0	-53.0	-48.1	

Table 20. Impact of climate change on cereal production under RCP8.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-4.4	-2.8	-6.6	-5.9	-16.8	-30.6	-52.3	-61.8	-62.7	-4.4	-2.8	-6.6	-5.9	-16.8	-30.6	-52.3	-66.4	-71.6
Burkina Faso	-2.7	-1.0	-5.1	-3.7	-6.5	-20.6	-28.5	-20.7	-13.4	-0.7	-1.3	-5.4	-3.9	-7.7	-21.5	-29.1	-16.1	-16.2
Cote d'Ivoire	-4.9	-3.3	-5.4	-2.0	-44.7	-45.4	-38.0	-36.9	-31.1	-4.9	-3.3	-5.4	-2.0	-44.7	-45.4	-38.0	-36.9	-31.1
Gambia	-2.8	-0.8	-5.0	-3.7	-7.3	-20.6	-28.3	-20.2	-13.8	-3.3	-0.8	-5.0	-3.7	-7.3	-20.6	-28.3	-20.7	-15.9
Ghana	-5.7	-4.1	-7.2	-6.6	-25.3	-34.0	-38.0	-30.8	-23.4	-5.7	-4.1	-7.2	-6.6	-25.3	-34.0	-38.0	-30.9	-23.6
Guinea	-2.5	-2.7	-3.4	-3.6	-27.0	-26.9	-32.1	-91.5	-93.5	-2.5	-2.7	-3.4	-3.6	-27.0	-26.9	-32.1	-91.5	-93.5
Guinea Bissau	-5.2	-3.9	-5.5	-7.7	-33.9	-39.9	-54.3	-65.5	-68.6	-5.2	-3.9	-5.5	-7.7	-33.9	-39.9	-54.3	-65.5	-68.6
Liberia	-1.8	-2.8	-2.7	-4.2	-45.5	-25.6	-31.7	-95.9	-96.9	-1.8	-2.8	-2.7	-4.2	-45.5	-25.6	-31.7	-95.9	-96.9
Mali	1.5	0.2	-4.1	-2.4	1.1	-19.2	-27.5	-20.4	-9.0	8.8	-0.9	-5.3	-3.3	-4.5	-21.8	-29.7	0.0	-8.7
Niger	39.2	5.5	0.6	1.3	98.7	-13.8	-22.6	-16.1	-0.2	43.0	3.8	-1.1	0.5	7.2	-14.7	-23.4	48.0	15.7
Nigeria	-3.6	-2.0	-5.6	-1.9	-9.7	-24.4	-31.4	-23.7	-10.7	-2.3	-2.3	-5.9	-2.1	-10.9	-25.4	-32.2	-17.4	-15.7
Senegal	2.5	2.9	-1.4	1.0	5.3	-14.6	-23.5	-17.1	9.9	17.4	1.4	-3.3	0.1	17.8	-18.2	-26.1	36.0	51.4
Sierra Leone	-3.2	-3.0	-3.0	-4.3	-82.3	-42.6	-36.4	-79.1	-82.8	-3.2	-3.0	-3.0	-4.3	-82.3	-42.6	-36.4	-79.1	-82.8
Togo	-6.1	-4.3	-7.8	-6.7	-21.9	-35.7	-50.0	-53.2	-53.0	-6.1	-4.3	-7.8	-6.7	-21.9	-35.7	-50.0	-53.2	-53.1
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-4.4	-2.8	-6.6	-5.9	-16.8	-30.6	-52.3	-61.8	-62.7	-4.4	-2.8	-6.6	-5.9	-16.8	-30.6	-52.3	-61.8	-62.7
Burkina Faso	-3.1	-1.0	-5.1	-3.7	-6.5	-20.6	-28.5	-20.7	-13.4	-2.6	-1.0	-5.1	-3.7	-6.5	-20.4	-28.5	-20.7	-13.4
Cote d'Ivoire	-4.9	-3.3	-5.4	-2.0	-44.7	-45.4	-38.0	-36.9	-31.1	-4.9	-3.3	-5.4	-2.0	-44.7	-45.4	-38.0	-36.9	-31.1
Gambia	-3.3	-0.8	-5.0	-3.7	-7.3	-20.6	-28.3	-20.2	-13.8	-2.8	-0.8	-5.0	-3.7	-7.3	-20.6	-28.3	-20.2	-13.8
Ghana	-5.7	-4.1	-7.2	-6.6	-25.3	-34.0	-38.0	-30.8	-23.4	-5.7	-4.1	-7.2	-6.6	-25.3	-34.0	-38.0	-30.8	-23.4
Guinea	-2.5	-2.7	-3.4	-3.6	-27.0	-26.9	-32.1	-91.5	-93.5	-2.5	-2.7	-3.4	-3.6	-27.0	-26.9	-32.1	-91.5	-93.5
Guinea Bissau	-5.2	-3.9	-5.5	-7.7	-33.9	-39.9	-54.3	-65.5	-68.6	-5.2	-3.9	-5.5	-7.7	-33.9	-39.9	-54.3	-65.5	-68.6
Liberia	-1.8	-2.8	-2.7	-4.2	-45.5	-25.6	-31.7	-95.9	-96.9	-1.8	-2.8	-2.7	-4.2	-45.5	-25.6	-31.7	-95.9	-96.9
Mali	1.6	0.2	-4.1	-2.4	1.1	-19.2	-27.5	-20.4	-9.0	-0.4	0.2	-4.1	-2.4	1.1	-17.1	-27.5	-20.4	-9.0
Niger	40.4	5.5	0.6	1.3	98.7	-13.8	-22.6	-16.1	-0.2	7.2	5.5	0.6	1.3	98.7	-10.3	-22.6	-16.1	-0.2
Nigeria	-3.7	-2.0	-5.6	-1.9	-9.7	-24.4	-31.4	-23.7	-10.7	-3.8	-2.0	-5.6	-1.9	-9.7	-23.4	-31.4	-23.7	-10.7
Senegal	3.0	2.9	-1.4	1.0	5.3	-14.6	-23.5	-17.1	9.9	3.2	2.9	-1.4	1.0	5.3	-3.6	-23.5	-17.1	9.9
Sierra Leone	-3.2	-3.0	-3.0	-4.3	-82.3	-42.6	-36.4	-79.1	-82.8	-3.2	-3.0	-3.0	-4.3	-82.3	-42.6	-36.4	-79.1	-82.8
Togo	-6.1	-4.3	-7.8	-6.7	-21.9	-35.7	-50.0	-53.2	-53.0	-6.1	-4.3	-7.8	-6.7	-21.9	-35.7	-50.0	-53.2	-53.0

Vegetable and fruits production

As reported in Table 21, vegetable and fruits production will increase for almost all countries in ECOWAs, except The Gambia, Niger, and Senegal under the moderate climate change regardless of socio-economic scenarios. This increase ranges between 1.8-75.2 percent (with an average of 26.0 percent). Under the moderate climate change, the production of vegetable and fruits in The Gambia, Niger and Senegal will first decrease until 2060 or 2070, and will increase thereafter until the end of the century. In these countries, the reduction in vegetable and fruit production ranges between 0.8-21.6 percent (with an average of 6.4 percent), regardless of socio-economic scenarios. We observe similar trends under the harsh climate change, except that more countries will experience a decrease in their productions of vegetable and fruits. Countries like Rep. of Benin, Burkina Faso, Mali, Niger, Nigeria, Senegal, and Togo will first face a decrease in their productions ranging between 0.1-10.8 percent (with an average of 3.8 percent), then an increase ranging between 0.5-67.7 percent (with an average of 29.9 percent) until the end of the century, regardless of socio-economic scenarios. Other countries such as Cote d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, and Sierra Leone will exhibit an increase in vegetable and fruits production oscillating between 1.4-81.2 percent (with an average of 34.2 percent), irrespective of socio-economic scenarios.

The observed disparities of the impact of climate change on production of vegetable and fruits at the country level also hold at the ACZ level. Indeed, there are ACZs experiencing a drop in vegetable and fruit production under both moderate, and harsh climate change. For example, ACZs 17, 19, and 20 experience a decrease in vegetable and fruit production from 2020 to 2030 under SSP1 for both sandy and loamy soils.

Table 21. Impact of climate change on vegetable and fruits production under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	5.5	8.5	7.9	3.0	9.1	27.8	52.4	30.1	20.9	5.5	8.5	7.9	3.0	9.1	27.8	52.4	30.1	20.9
Burkina Faso	5.5	8.2	7.3	1.8	5.5	24.8	51.7	32.5	23.7	5.5	8.2	7.3	1.8	5.5	24.8	51.7	32.5	23.7
Cote d'Ivoire	8.8	11.3	11.9	12.1	25.1	43.0	63.8	37.9	29.7	8.8	11.3	11.9	12.1	25.1	43.0	63.8	37.9	29.7
Gambia	-2.9	-0.8	-2.9	-6.4	-12.0	9.1	35.3	27.6	25.8	-2.9	-0.8	-2.9	-6.4	-12.0	9.1	35.3	27.6	25.8
Ghana	9.2	11.1	11.8	12.9	27.9	45.2	64.0	37.1	28.0	9.2	11.1	11.8	12.9	27.9	45.2	64.0	37.1	28.0
Guinea	11.1	16.4	16.5	20.1	30.6	48.5	71.3	46.2	40.9	11.1	16.4	16.5	20.1	30.6	48.5	71.3	46.2	40.9
Guinea Bissau	8.8	10.6	10.5	10.5	23.0	39.7	58.1	32.4	24.1	8.8	10.6	10.5	10.5	23.0	39.7	58.1	32.4	24.1
Liberia	13.3	18.5	23.4	31.9	46.4	56.2	75.2	48.4	45.6	13.3	18.5	23.4	31.9	46.4	56.2	75.2	48.4	45.6
Mali	4.0	7.0	6.3	2.0	2.4	22.4	47.9	31.4	23.7	4.0	7.0	6.3	2.0	2.4	22.4	47.9	31.4	23.7
Niger	-2.6	-6.0	0.2	-6.2	-21.6	-12.4	7.3	10.4	7.5	-2.6	-6.0	0.2	-6.2	-21.6	-12.4	7.3	10.4	7.5
Nigeria	2.0	6.1	5.0	3.5	5.0	25.7	51.3	34.0	28.4	2.0	6.1	5.0	3.5	5.0	25.7	51.3	34.0	28.4
Senegal	-1.9	-1.2	0.4	-3.8	-8.8	5.5	22.9	19.3	17.3	-1.9	-1.2	0.4	-3.8	-8.8	5.5	23.1	-7.5	24.0
Sierra Leone	14.5	19.0	20.9	31.0	47.3	59.0	74.6	45.6	42.8	14.5	19.0	20.9	31.0	47.3	59.0	74.6	45.6	42.8
Togo	6.9	10.4	10.4	7.4	15.1	34.8	61.6	38.8	31.7	6.9	10.4	10.4	7.4	15.1	34.8	61.6	38.8	31.7
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	5.5	8.5	7.9	3.0	9.1	27.8	52.4	30.1	20.9	5.5	8.5	7.9	3.0	9.1	27.8	52.4	30.1	20.9
Burkina Faso	5.5	8.2	7.3	1.8	5.5	24.8	51.7	32.5	23.7	5.5	8.2	7.3	1.8	5.5	24.8	51.7	32.5	23.7
Cote d'Ivoire	8.8	11.3	11.9	12.1	25.1	43.0	63.8	37.9	29.7	8.8	11.3	11.9	12.1	25.1	43.0	63.8	37.9	29.7
Gambia	-2.9	-0.8	-2.9	-6.4	-12.0	9.1	35.3	27.6	25.8	-2.9	-0.8	-2.9	-6.4	-12.0	9.1	35.3	27.6	25.8
Ghana	9.2	11.1	11.8	12.9	27.9	45.2	64.0	37.1	28.0	9.2	11.1	11.8	12.9	27.9	45.2	64.0	37.1	28.0
Guinea	11.1	16.4	16.5	20.1	30.6	48.5	71.3	46.2	40.9	11.1	16.4	16.5	20.1	30.6	48.5	71.3	46.2	40.9
Guinea Bissau	8.8	10.6	10.5	10.5	23.0	39.7	58.1	32.4	24.1	8.8	10.6	10.5	10.5	23.0	39.7	58.1	32.4	24.1
Liberia	13.3	18.5	23.4	31.9	46.4	56.2	75.2	48.4	45.6	13.3	18.5	23.4	31.9	46.4	56.2	75.2	48.4	45.6
Mali	4.0	7.0	6.3	2.0	2.4	22.4	47.9	31.4	23.7	4.0	7.0	6.3	2.0	2.4	22.4	47.9	31.4	23.7
Niger	-2.6	-6.0	0.2	-6.2	-21.6	-12.4	7.3	10.4	7.5	-2.6	-6.0	0.2	-6.2	-21.6	-12.4	7.3	10.4	7.5
Nigeria	2.0	6.1	5.0	3.5	5.0	25.7	51.3	34.0	28.4	2.0	6.1	5.0	3.5	5.0	25.7	51.3	34.0	28.4
Senegal	-1.9	-1.2	0.4	-3.8	-8.8	5.5	22.9	19.3	17.3	-1.9	-1.2	0.4	-3.8	-8.8	5.5	22.9	19.3	17.3
Sierra Leone	14.5	19.0	20.9	31.0	47.3	59.0	74.6	45.6	42.8	14.5	19.0	20.9	31.0	47.3	59.0	74.6	45.6	42.8
Togo	6.9	10.4	10.4	7.4	15.1	34.8	61.6	38.8	31.7	6.9	10.4	10.4	7.4	15.1	34.8	61.6	38.8	31.7

Table 22. Impact of climate change on vegetable and fruits production under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100		
Benin	-1.6	-0.1	-2.3	1.9	7.7	32.4	59.1	51.3	43.2	-1.6	-0.1	-2.3	1.9	7.7	32.4	59.1	51.3	43.2		
Burkina Faso	-1.7	0.0	-1.7	1.0	4.6	29.3	59.0	52.3	42.6	-1.7	0.0	-1.7	1.0	4.6	29.3	59.0	52.3	42.6		
Cote d'Ivoire	1.9	2.3	1.4	9.7	22.7	48.4	68.4	57.7	51.8	1.9	2.3	1.4	9.7	22.7	48.4	68.4	57.7	51.8		
Gambia	-9.6	-5.9	-4.1	-2.0	-9.3	16.7	48.4	46.3	30.5	-9.6	-5.9	-4.1	-2.0	-9.3	16.7	48.4	46.3	30.5		
Ghana	2.2	2.5	1.6	11.3	25.4	51.3	68.2	56.5	49.9	2.2	2.5	1.6	11.3	25.4	51.3	68.2	56.5	49.9		
Guinea	5.6	7.9	7.6	15.2	28.6	55.0	80.0	68.3	62.4	5.6	7.9	7.6	15.2	28.6	55.0	80.0	68.3	62.4		
Guinea Bissau	1.4	1.6	-0.1	8.2	19.9	45.2	64.2	53.4	46.1	1.4	1.6	-0.1	8.2	19.9	45.2	64.2	53.4	46.1		
Liberia	7.4	4.4	8.5	19.6	41.4	58.9	78.7	66.3	65.5	7.4	4.4	8.5	19.6	41.4	58.9	78.7	66.3	65.5		
Mali	-1.8	0.3	-0.7	1.7	2.7	28.2	59.9	53.3	39.5	-1.8	0.3	-0.7	1.7	2.7	28.2	59.9	53.3	39.5		
Niger	-4.9	-7.8	-2.3	-2.9	-10.8	0.5	17.9	18.2	14.9	-4.9	-7.8	-2.3	-2.9	-10.8	0.5	17.9	18.2	14.9		
Nigeria	-3.7	0.0	-0.5	3.7	5.1	32.4	62.4	54.6	42.7	-3.7	0.0	-0.5	3.7	5.1	32.4	62.4	54.6	42.7		
Senegal	-8.7	-4.5	-1.8	0.9	-8.0	8.6	28.3	25.5	20.0	-8.7	-4.5	-1.8	0.9	-8.0	8.6	28.5	25.7	24.4		
Sierra Leone	8.8	7.3	7.0	20.8	41.0	64.2	81.2	67.3	62.2	8.8	7.3	7.0	20.8	41.0	64.2	81.2	67.3	62.2		
Togo	-0.1	0.9	-0.3	4.9	13.9	39.0	67.7	60.0	54.5	-0.1	0.9	-0.3	4.9	13.9	39.0	67.7	60.0	54.5		
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100		
Benin	-1.6	-0.1	-2.3	1.9	7.7	32.4	59.1	51.3	43.2	-1.6	-0.1	-2.3	1.9	7.7	32.4	59.1	51.3	43.2		
Burkina Faso	-1.7	0.0	-1.7	1.0	4.6	29.3	59.0	52.3	42.6	-1.7	0.0	-1.7	1.0	4.6	29.3	59.0	52.3	42.6		
Cote d'Ivoire	1.9	2.3	1.4	9.7	22.7	48.4	68.4	57.7	51.8	1.9	2.3	1.4	9.7	22.7	48.4	68.4	57.7	51.8		
Gambia	-9.6	-5.9	-4.1	-2.0	-9.3	16.7	48.4	46.3	30.5	-9.6	-5.9	-4.1	-2.0	-9.3	16.7	48.4	46.3	30.5		
Ghana	2.2	2.5	1.6	11.3	25.4	51.3	68.2	56.5	49.9	2.2	2.5	1.6	11.3	25.4	51.3	68.2	56.5	49.9		
Guinea	5.6	7.9	7.6	15.2	28.6	55.0	80.0	68.3	62.4	5.6	7.9	7.6	15.2	28.6	55.0	80.0	68.3	62.4		
Guinea Bissau	1.4	1.6	-0.1	8.2	19.9	45.2	64.2	53.4	46.1	1.4	1.6	-0.1	8.2	19.9	45.2	64.2	53.4	46.1		
Liberia	7.4	4.4	8.5	19.6	41.4	58.9	78.7	66.3	65.5	7.4	4.4	8.5	19.6	41.4	58.9	78.7	66.3	65.5		
Mali	-1.8	0.3	-0.7	1.7	2.7	28.2	59.9	53.3	39.5	-1.8	0.3	-0.7	1.7	2.7	28.2	59.9	53.3	39.5		
Niger	-4.9	-7.8	-2.3	-2.9	-10.8	0.5	17.9	18.2	14.9	-4.9	-7.8	-2.3	-2.9	-10.8	0.5	17.9	18.2	14.9		
Nigeria	-3.7	0.0	-0.5	3.7	5.1	32.4	62.4	54.6	42.7	-3.7	0.0	-0.5	3.7	5.1	32.4	62.4	54.6	42.7		
Senegal	-8.7	-4.5	-1.8	0.9	-8.0	8.6	28.3	25.5	20.0	-8.7	-4.5	-1.8	0.9	-8.0	8.6	28.3	25.5	20.0		
Sierra Leone	8.8	7.3	7.0	20.8	41.0	64.2	81.2	67.3	62.2	8.8	7.3	7.0	20.8	41.0	64.2	81.2	67.3	62.2		
Togo	-0.1	0.9	-0.3	4.9	13.9	39.0	67.7	60.0	54.5	-0.1	0.9	-0.3	4.9	13.9	39.0	67.7	60.0	54.5		

Oilseeds production

Both moderate, and harsh climate change will hamper oilseeds production in all the countries at least for some years (Tables 23, and 24). Under the moderate climate change, countries like Burkina Faso, The Gambia, Mali, Nigeria and Senegal will experience a decrease in oilseeds production all over the study period ranging between 3.5-81.6 percent for SSPs 1, 3 and 4 (with an average of 18.7, 19.6 and 20.3 percent respectively for SSP1, SSP3 and SSP4), and between 2.9-92.6 percent (with an average of 24.6 percent) for SSP2. For these countries, a similar trend is observed for the harsh climate change, except that the impact is now ranged between 0.7-81.7 percent (with an average of about 22.5 percent) for SSPs 1, 3 and 4, and between 0.7-92.9 percent (with an average of 31.2 percent) for SSP2. Other countries such as Rep. of Benin, Cote d'Ivoire, Ghana, Guinea, guinea Bissau, Liberia, Sierra Leone and Togo exhibit a climate change impact on oilseeds production having a U-shape form under moderate climate change regardless of socio-economic scenarios. Indeed, these countries will first experience a decrease in oilseeds production ranging between 0.5-39.2 percent (with an average of 7.6 percent) and then an increase ranging between 1.4-82.3 percent (with an average of 25.4 percent), except Sierra Leone and Liberia, which will experience an increase of more than 100 percent. For these countries, except Sierra Leone and Liberia, the production of oilseeds will fluctuate between -38.1 percent and 49.7 percent (with an average of 0.73 percent) for SSPs 1, 3 and 4, and between -38.1 percent and 50.5 percent (with an average of 0.75 percent) for SSP2 under harsh climate change.

Moderate and harsh climate change will also have differentiated impacts at ACZ level. For example, oilseeds production rises at an exponential rate on clay soils in ACZ 27 under SSP1 from 2055 until the end of the century

under RCP4.5, and until 2095 under RCP8.5 (the average increased rate is 1765.81%, and 1791.17%, respectively under RCP4.5 and RCP8.5).

Table 23. Impact of climate change on oil seeds production under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-1.4	-7.2	-6.5	-15.7	-17.8	-9.6	18.9	55.4	69.4	-1.4	-7.2	-6.5	-15.7	-17.8	-9.6	18.9	55.8	70.1
Burkina Faso	-5.2	-11.4	-8.6	-18.2	-30.4	-24.1	-11.1	-4.4	-16.4	-5.2	-11.4	-8.8	-18.3	-28.7	-23.8	-17.7	-2.9	-13.3
Cote d'Ivoire	-0.5	-2.3	-5.1	-13.9	-21.3	-39.2	-28.0	31.2	6.2	-0.5	-2.3	-5.1	-13.9	-21.3	-39.2	-28.0	31.2	6.2
Gambia	-6.2	-12.2	-8.4	-19.4	-25.5	-21.1	-9.1	-3.5	-13.8	-6.2	-12.2	-8.4	-19.4	-25.5	-21.1	-9.1	-3.4	-13.7
Ghana	-2.0	-0.9	-3.6	-7.8	7.3	15.3	15.1	18.7	1.4	-2.0	-0.9	-3.6	-7.8	7.3	15.3	15.1	18.7	1.4
Guinea	-2.0	-1.7	-3.7	-8.9	-3.0	10.9	45.7	82.3	24.1	-2.0	-1.7	-3.7	-8.9	-3.0	10.9	45.7	82.3	24.1
Guinea Bissau	-2.9	-4.8	-5.0	-5.3	3.2	13.3	19.8	23.4	17.8	-2.9	-4.8	-5.0	-5.3	3.2	13.3	19.8	23.4	17.8
Liberia	-5.9	-3.1	-3.7	-3.7	204.9	614.2	952.4	1597.1	1164.5	-5.9	-3.1	-3.7	-3.7	204.9	614.2	952.4	1597.1	1164.5
Mali	-8.0	-12.9	-7.2	-17.1	-47.4	-38.1	-25.9	-21.1	-37.7	-8.0	-12.9	-8.4	-17.4	-45.6	-59.4	-74.4	-60.7	-54.6
Niger	-9.2	-13.5	-6.7	-16.9	-81.6	-34.2	-27.7	-24.1	-27.4	-9.2	-13.5	-9.0	-16.9	-70.6	-89.8	-91.0	-92.6	-89.9
Nigeria	-6.1	-10.7	-8.0	-18.0	-26.2	-24.4	-8.8	5.4	-14.8	-6.1	-10.7	-8.1	-18.1	-24.3	-23.3	-18.0	15.6	-5.3
Senegal	-8.7	-13.4	-7.1	-17	-32.6	-41.8	-26.5	-22.8	-47.7	-8.7	-13.4	-8.0	-17.6	-36.9	-29.5	-80.0	-23.3	-23.7
Sierra Leone	-5.8	-3.6	-3.9	-2.9	148.4	299.5	390.4	520.6	261.1	-5.8	-3.6	-3.9	-2.9	148.4	299.5	390.4	520.6	261.1
Togo	-1.5	-5.9	-4.8	-16	-16.6	-7.9	14.0	35.3	30.7	-1.5	-5.9	-4.8	-16	-16.6	-7.9	14.0	35.3	30.7
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-1.4	-7.2	-6.5	-15.7	-17.8	-9.6	18.9	55.4	69.4	-1.4	-7.2	-6.5	-15.7	-17.8	-9.6	18.9	55.4	69.4
Burkina Faso	-5.2	-11.4	-8.6	-18.2	-30.4	-24.1	-11.1	-4.4	-16.4	-5.2	-11.4	-8.6	-18.2	-30.4	-24.1	-11.1	-6.4	-16.4
Cote d'Ivoire	-0.5	-2.3	-5.1	-13.9	-21.3	-39.2	-28.0	31.2	6.2	-0.5	-2.3	-5.1	-13.9	-21.3	-39.2	-28.0	31.2	6.2
Gambia	-6.2	-12.2	-8.4	-19.4	-25.5	-21.1	-9.1	-3.5	-13.8	-6.2	-12.2	-8.4	-19.4	-25.5	-21.1	-9.1	-3.5	-13.8
Ghana	-2.0	-0.9	-3.6	-7.8	7.3	15.3	15.1	18.7	1.4	-2.0	-0.9	-3.6	-7.8	7.3	15.3	15.1	18.7	1.4
Guinea	-2.0	-1.7	-3.7	-8.9	-3.0	10.9	45.7	82.3	24.1	-2.0	-1.7	-3.7	-8.9	-3.0	10.9	45.7	82.3	24.1
Guinea Bissau	-2.9	-4.8	-5.0	-5.3	3.2	13.3	19.8	23.4	17.8	-2.9	-4.8	-5.0	-5.3	3.2	13.3	19.8	23.4	17.8
Liberia	-5.9	-3.1	-3.7	-3.7	204.9	614.2	952.4	1597.1	1164.5	-5.9	-3.1	-3.7	-3.7	204.9	614.2	952.4	1597.1	1164.5
Mali	-8.0	-12.9	-7.2	-17.1	-47.4	-38.1	-25.9	-21.1	-37.7	-8.0	-12.9	-7.2	-17.1	-47.4	-38.1	-25.9	-33.5	-37.7
Niger	-9.2	-13.5	-6.7	-16.9	-81.6	-34.2	-27.7	-24.1	-27.4	-9.2	-13.5	-6.7	-16.9	-81.6	-34.2	-27.7	-27.2	-27.4
Nigeria	-6.1	-10.7	-8.0	-18.0	-26.2	-24.4	-8.8	5.4	-14.8	-6.1	-10.7	-8.0	-18.0	-26.2	-24.4	-8.8	1.9	-14.8
Senegal	-8.9	-13.4	-7.1	-17	-32.6	-41.8	-26.5	-22.8	-47.7	-8.7	-13.4	-7.1	-17	-32.6	-41.8	-26.5	-42.5	-47.7
Sierra Leone	-5.8	-3.6	-3.9	-2.9	148.4	299.5	390.4	520.6	261.1	-5.8	-3.6	-3.9	-2.9	148.4	299.5	390.4	520.6	261.1
Togo	-1.5	-5.9	-4.8	-16	-16.6	-7.9	14.0	35.3	30.7	-1.5	-5.9	-4.8	-16	-16.6	-7.9	14.0	35.3	30.7

Table 24. Impact of climate change on oil seeds production under RCP8.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	2.0	-4.8	-9.9	-16.3	-14.7	-5.2	14.4	29.9	49.7	2.0	-4.8	-9.9	-16.3	-14.7	-5.2	14.4	30.3	50.5
Burkina Faso	-1.3	-10.9	-12.4	-21.0	-25.6	-19.4	-16.3	-21.1	-30.1	-1.3	-16.5	-12.0	-20.8	-23.1	-20.6	-23.0	-21.2	-25.3
Cote d'Ivoire	1.9	0.2	-7.1	-15.9	-0.8	-38.1	-28.6	-20.7	-10.0	1.9	0.2	-7.1	-15.9	-0.8	-38.1	-28.6	-20.7	-10.0
Gambia	-0.7	-8.9	-10.1	-19.8	-21.9	-17.1	-13.4	-18.7	-25.5	-0.7	-8.9	-10.1	-19.8	-21.9	-17.1	-13.4	-18.5	-24.9
Ghana	0.9	-1.7	-9.0	-15.6	8.9	16.2	13.4	4.2	-14.9	0.9	-1.7	-9.0	-15.6	8.9	16.2	13.4	4.2	-14.9
Guinea	0.9	-0.7	-8.4	-14.8	0.1	13.4	45.8	38.7	-9.4	0.9	-0.7	-8.4	-14.8	0.1	13.4	45.8	38.7	-9.4
Guinea Bissau	2.1	-3.4	-11.2	-17.6	-3.8	12.8	22.3	23.2	14.1	2.1	-3.4	-11.2	-17.6	-3.8	12.8	22.3	23.2	14.1
Liberia	0.0	2.4	-4.7	-9.6	161.3	654.6	1032.7	1590.3	-2.8	0.0	2.4	-4.7	-9.6	161.3	654.6	1032.7	1590.3	-2.8
Mali	-10.2	-19.9	-15.9	-25.1	-46.8	-28.5	-27.6	-26.6	-50.2	-10.2	-45.7	-15.7	-26.2	-42.6	-57.9	-75.5	-67.1	-60.1
Niger	-12.8	-23.0	-17.4	-24.0	-81.7	-29.1	-28.9	-27.0	-36.5	-12.8	-41.4	-19.3	-24.1	-70.6	-89.3	-91.3	-92.9	-90.9
Nigeria	-2.3	-9.9	-11.6	-22.8	-20.4	-18.2	-10.6	-11.6	-35.9	-2.3	-13.6	-11.2	-22.8	-17.5	-18.8	-19.7	-5.6	-23.0
Senegal	-11.5	-21.7	-16.8	-25.0	-33.3	-28.3	-28.0	-26.8	-57.7	-11.5	-59.7	-15.5	-28.4	-35.8	-26.7	-80.8	-29.9	-32.5
Sierra Leone	-0.4	0.6	-6.3	-10.8	115.2	316.7	423.4	519.7	-6.0	-0.4	0.6	-6.3	-10.8	115.2	316.7	423.4	519.7	-6.0
Togo	1.6	-1.3	-7.2	-14.9	-13.1	-2.8	10.4	17.3	17.2	1.6	-1.3	-7.2	-14.9	-13.1	-2.8	10.4	17.3	17.2
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	2.0	-4.8	-9.9	-16.3	-14.7	-5.2	14.4	29.9	49.7	2.0	-4.8	-9.9	-16.3	-14.7	-5.2	14.4	29.9	49.7
Burkina Faso	-1.3	-10.9	-12.4	-21.0	-25.6	-19.4	-16.3	-21.1	-30.1	-1.3	-10.9	-12.4	-21.0	-25.6	-20.8	-16.3	-21.1	-30.1
Cote d'Ivoire	1.9	0.2	-7.1	-15.9	-0.8	-38.1	-28.6	-20.7	-10.0	1.9	0.2	-7.1	-15.9	-0.8	-38.1	-28.6	-20.7	-10.0
Gambia	-0.7	-8.9	-10.1	-19.8	-21.9	-17.1	-13.4	-18.7	-25.5	-0.7	-8.9	-10.1	-19.8	-21.9	-17.1	-13.4	-18.7	-25.5
Ghana	0.9	-1.7	-9.0	-15.6	8.9	16.2	13.4	4.2	-14.9	0.9	-1.7	-9.0	-15.6	8.9	16.2	13.4	4.2	-14.9
Guinea	0.9	-0.7	-8.4	-14.8	0.1	13.4	45.8	38.7	-9.4	0.9	-0.7	-8.4	-14.8	0.1	13.4	45.8	38.7	-9.4
Guinea Bissau	2.1	-3.4	-11.2	-17.6	-3.8	12.8	22.3	23.2	14.1	2.1	-3.4	-11.2	-17.6	-3.8	12.8	22.3	23.2	14.1
Liberia	0.0	2.4	-4.7	-9.6	161.3	654.6	1032.7	1590.3	-2.8	0.0	2.4	-4.7	-9.6	161.3	654.6	1032.7	1590.3	-2.8
Mali	-10.2	-19.9	-15.9	-25.1	-46.8	-28.5	-27.6	-26.6	-50.2	-10.2	-19.9	-15.9	-25.1	-46.8	-35.1	-27.6	-26.6	-50.2
Niger	-12.8	-23.0	-17.4	-24.0	-81.7	-29.1	-28.9	-27.0	-36.5	-12.8	-41.4	-19.3	-24.1	-70.6	-89.3	-91.3	-92.9	-90.9
Nigeria	-2.3	-9.9	-11.6	-22.8	-20.4	-18.2	-10.6	-11.6	-35.9	-2.3	-9.9	-11.6	-22.8	-20.4	-20.0	-10.6	-11.6	-35.9
Senegal	-11.7	-21.7	-17.1	-25.0	-33.3	-28.3	-28.0	-26.8	-57.7	-11.5	-21.7	-16.8	-25.0	-33.3	-38.8	-28.0	-26.8	-57.7
Sierra Leone	-0.4	0.6	-6.3	-10.8	115.2	316.7	423.4	519.7	-6.0	-0.4	0.6	-6.3	-10.8	115.2	316.7	423.4	519.7	-6.0
Togo	1.6	-1.3	-7.2	-14.9	-13.1	-2.8	10.4	17.3	17.2	1.6	-1.3	-7.2	-14.9	-13.1	-2.8	10.4	17.3	17.2

Sugarcane production

As reported in Tables 25 and 26, sugarcane production will increase in most of the years under both moderate and harsh climate change for all countries except Liberia and Sierra Leone. This trend does not depend on socio-economic scenarios. Except for Liberia, Sierra Leone, Guinea-Bissau and Nigeria, the increase in sugarcane production is ranged between 0.5-78.7 percent (with an average of 22.8 percent) under RCP4.5, and between 1.3-64.2 percent (with an average of 26.4 for SSPs 1, 3 and 4, and an average of 27.0 percent for SSP2) under RCP8.5. Guinea-Bissau and Nigeria will exhibit an increase in sugarcane production that will exceed 100 percent in some years depending on climate and socio-economic scenarios. Liberia and Sierra Leone will experience a decrease in sugarcane production until 2060, and thereafter the production will increase until 2095 under both moderate and harsh climate change, regardless of socio-economic scenarios. However, the observed U-shape form will stand between -17.1 percent and 31.1 percent for the moderate climate change, and between -13.4 percent and 23.2 percent for the harsh climate change. The heterogeneity of climate change impacts on sugarcane production is also observed at ACZ level. For example, on loamy soils in ACZ 9, the sugarcane production will decrease in almost all years under both moderate and harsh climate change coupled with SSP1.

Cotton production

As reported in Tables 27 and 28, almost all countries in ECOWAS region will experience a decrease in cotton production between 2050 and 2060, regardless of climate and socio-economic scenarios. This decrease in cotton production will range between 1.3-17.4 percent (with an average of 7.2 percent for SSPs 1, 3 and 4, and an average of 6.2 percent for SSP 2) under

RCP4.5, and between 0.1-13.9 percent (with an average of 6.0 percent for SSPs 1, 3 and 4, and an average of 5.3 percent for SSP2) under RCP8.5. Cotton production will decrease in Burkina Faso, Mali, Niger, and Senegal between 2020 and 2060, irrespective of climate and socio-economic scenarios. However, this decrease in cotton production ranges between 1.3-26.1 percent for SSP1, 1.6-67.7 percent for SSP2, 1.3-29.1 percent for SSP3 and 1.3-21.0 percent for SSP4 under RCP4.5, whilst it ranges between 3.4-55.9 percent for SSP1, 4.3-68.7 percent for SSP2, 3.4-55.9 percent for SSP3 and 3.4-17.4 percent for SSP4 under RCP8.5.

Table 25. Impact of climate change on sugarcane production under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	2.1	13.4	5.3	15.0	23.0	40.1	21.6	20.4	24.4	2.1	13.4	5.3	15.0	23.0	40.1	21.6	20.4	24.4	
Burkina Faso	9.7	17.9	6.4	14.5	48.1	57.3	43.1	36.9	26.5	9.7	17.9	6.4	14.5	48.1	57.3	43.1	36.9	26.5	
Cote d'Ivoire	-2.0	7.0	1.1	9.1	16.7	31.6	14.0	12.6	11.6	-2.0	7.0	1.1	9.1	16.7	31.6	14.0	12.6	11.6	
Ghana	0.5	11.8	4.1	12.0	22.6	36.0	16.3	14.4	14.1	0.5	11.8	4.1	12.0	22.6	36.0	16.3	14.4	14.1	
Guinea	-3.1	3.8	-2.7	3.7	11.3	28.1	11.9	11.2	9.4	-3.1	3.8	-2.7	3.7	11.3	28.1	11.9	11.2	9.4	
Guinea Bissau	2.9	14.0	9.3	19.9	35.2	130.2	106.7	99.6	94.8	2.9	14.0	9.3	19.9	35.2	130.2	106.7	99.6	94.8	
Liberia	-17.1	-12.7	-10.4	-8.2	-6.8	23.5	5.4	3.4	-3.6	-17.1	-12.7	-10.4	-8.2	-6.8	23.5	5.4	3.4	-3.6	
Mali	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	
Niger	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	
Nigeria	11.2	120.4	5.3	14.8	60.4	360.5	317.7	351.8	327.0	11.2	120.4	5.3	14.8	60.4	360.5	317.7	351.8	327.0	
Senegal	5.5	9.0	1.5	5.2	28.9	30.6	23.0	20.9	10.4	5.5	9.0	1.5	5.2	28.9	30.6	23.9	21.5	31.7	
Sierra Leone	-16.8	-12.3	-9.7	-7.2	-4.9	31.1	12.3	9.7	1.9	-16.8	-12.3	-9.7	-7.2	-4.9	31.1	12.3	9.7	1.9	
Togo	-0.2	10.2	3.5	12.4	20.6	35.9	17.7	16.1	17.2	-0.2	10.2	3.5	12.4	20.6	35.9	17.7	16.1	17.2	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	2.1	13.4	5.3	15.0	23.0	40.1	21.6	20.4	24.4	2.1	13.4	5.3	15.0	23.0	40.1	21.6	20.4	24.4	
Burkina Faso	9.7	17.9	6.4	14.5	48.1	57.3	43.1	36.9	26.5	9.7	17.9	6.4	14.5	48.1	57.3	43.1	36.9	26.5	
Cote d'Ivoire	-2.0	7.0	1.1	9.1	16.7	31.6	14.0	12.6	11.6	-2.0	7.0	1.1	9.1	16.7	31.6	14.0	12.6	11.6	
Ghana	0.5	11.8	4.1	12.0	22.6	36.0	16.3	14.4	14.1	0.5	11.8	4.1	12.0	22.6	36.0	16.3	14.4	14.1	
Guinea	-3.1	3.8	-2.7	3.7	11.3	28.1	11.9	11.2	9.4	-3.1	3.8	-2.7	3.7	11.3	28.1	11.9	11.2	9.4	
Guinea Bissau	2.9	14.0	9.3	19.9	35.2	130.2	106.7	99.6	94.8	2.9	14.0	9.3	19.9	35.2	130.2	106.7	99.6	94.8	
Liberia	-17.1	-12.7	-10.4	-8.2	-6.8	23.5	5.4	3.4	-3.6	-17.1	-12.7	-10.4	-8.2	-6.8	23.5	5.4	3.4	-3.6	
Mali	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	
Niger	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	18.0	22.1	7.9	17.2	73.0	78.7	68.2	54.5	34.2	
Nigeria	11.2	120.4	5.3	14.8	60.4	360.5	317.7	351.8	327.0	11.2	120.4	5.3	14.8	60.4	360.5	317.7	351.8	327.0	
Senegal	5.5	9.0	1.5	5.2	28.9	30.6	23.0	20.9	10.4	5.5	9.0	1.5	5.2	28.9	30.6	23.0	20.9	10.4	
Sierra Leone	-16.8	-12.3	-9.7	-7.2	-4.9	31.1	12.3	9.7	1.9	-16.8	-12.3	-9.7	-7.2	-4.9	31.1	12.3	9.7	1.9	
Togo	-0.2	10.2	3.5	12.4	20.6	35.9	17.7	16.1	17.2	-0.2	10.2	3.5	12.4	20.6	35.9	17.7	16.1	17.2	

Table 26. Impact of climate change on sugarcane production under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	-0.9	10.0	14.2	24.5	29.7	41.1	29.9	36.7	31.2	-0.9	10.0	14.2	24.5	29.7	41.1	29.9	36.7	31.2	
Burkina Faso	6.1	17.1	8.5	19.6	41.5	52.2	44.8	49.4	40.4	6.1	17.1	8.5	19.6	41.5	52.2	44.8	49.4	40.4	
Cote d'Ivoire	1.7	11.2	11.4	15.2	22.0	33.1	26.3	31.8	34.6	1.7	11.2	11.4	15.2	22.0	33.1	26.3	31.8	34.6	
Ghana	-0.3	11.1	10.3	18.5	26.8	39.3	30.1	35.9	33.6	-0.3	11.1	10.3	18.5	26.8	39.3	30.1	35.9	33.6	
Guinea	2.2	9.8	8.0	7.6	14.3	27.3	24.1	31.1	35.8	2.2	9.8	8.0	7.6	14.3	27.3	24.1	31.1	35.8	
Guinea Bissau	1.4	11.5	15.3	26.3	37.6	130.8	116.4	121.4	105.3	1.4	11.5	15.3	26.3	37.6	130.8	116.4	121.4	105.3	
Liberia	-13.4	-8.9	-4.9	-9.3	-4.7	15.9	10.1	8.0	7.5	-13.4	-8.9	-4.9	-9.3	-4.7	15.9	10.1	8.0	7.5	
Mali	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	
Niger	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	
Nigeria	6.0	21.9	12.9	22.3	52.2	347.6	311.0	340.9	43.8	6.0	21.9	12.9	22.3	52.2	347.6	311.0	340.9	43.8	
Senegal	7.2	11.2	-3.1	3.3	16.7	20.4	12.1	15.8	6.9	7.2	11.2	-3.1	3.3	16.7	18.6	12.9	-20.3	42.8	
Sierra Leone	-13.3	-8.7	-4.6	-8.5	-3.2	23.2	16.9	14.3	12.7	-13.3	-8.7	-4.6	-8.5	-3.2	23.2	16.9	14.3	12.7	
Togo	1.3	11.9	13.4	20.2	26.9	38.1	29.2	34.7	33.9	1.3	11.9	13.4	20.2	26.9	38.1	29.2	34.7	33.9	
SSP3: Civil Society to the Rescue?										SSP4: Save Yourself									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	-0.9	10.0	14.2	24.5	29.7	41.1	29.9	36.7	31.2	-0.9	10.0	14.2	24.5	29.7	41.1	29.9	36.7	31.2	
Burkina Faso	6.1	17.1	8.5	19.6	41.5	52.2	44.8	49.4	40.4	6.1	17.1	8.5	19.6	41.5	52.2	44.8	49.4	40.4	
Cote d'Ivoire	1.7	11.2	11.4	15.2	22.0	33.1	26.3	31.8	34.6	1.7	11.2	11.4	15.2	22.0	33.1	26.3	31.8	34.6	
Ghana	-0.3	11.1	10.3	18.5	26.8	39.3	30.1	35.9	33.6	-0.3	11.1	10.3	18.5	26.8	39.3	30.1	35.9	33.6	
Guinea	2.2	9.8	8.0	7.6	14.3	27.3	24.1	31.1	35.8	2.2	9.8	8.0	7.6	14.3	27.3	24.1	31.1	35.8	
Guinea Bissau	1.4	11.5	15.3	26.3	37.6	130.8	116.4	121.4	105.3	1.4	11.5	15.3	26.3	37.6	130.8	116.4	121.4	105.3	
Liberia	-13.4	-8.9	-4.9	-9.3	-4.7	15.9	10.1	8.0	7.5	-13.4	-8.9	-4.9	-9.3	-4.7	15.9	10.1	8.0	7.5	
Mali	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	
Niger	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	14.9	25.0	9.7	21.5	56.9	64.2	57.8	58.6	45.5	
Nigeria	6.0	21.9	12.9	22.3	52.2	347.6	311.0	340.9	43.8	6.0	21.9	12.9	22.3	52.2	347.6	311.0	340.9	43.8	
Senegal	7.2	11.2	-3.1	3.3	16.7	20.4	12.1	15.8	6.9	7.2	11.2	-3.1	3.3	16.7	20.4	12.1	15.8	6.9	
Sierra Leone	-13.3	-8.7	-4.6	-8.5	-3.2	23.2	16.9	14.3	12.7	-13.3	-8.7	-4.6	-8.5	-3.2	23.2	16.9	14.3	12.7	
Togo	1.3	11.9	13.4	20.2	26.9	38.1	29.2	34.7	33.9	1.3	11.9	13.4	20.2	26.9	38.1	29.2	34.7	33.9	

Table 27. Impact of climate change on cotton production under RCP4.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	1.7	8.8	0.2	-5.1	3.2	101.6	416.9	284.3	114.9	1.7	8.8	0.2	-5.1	3.2	101.6	416.9	284.3	114.9
Burkina Faso	-6.7	-1.4	-3.3	-11.8	-18.4	52.8	97.2	44.7	26.7	-6.7	-35.1	-1.6	-9.2	-10.0	303.1	556.5	311.1	272.5
Cote d'Ivoire	0.5	7.3	-2.0	-7.0	1.3	234.9	522.0	43.4	19.3	0.5	7.3	-2.0	-7.0	1.3	234.9	522.0	43.4	19.3
Gambia	0.5	7.5	-2.1	-9.1	-3.3	36.1	59.5	41.8	17.0	0.5	7.5	-2.1	-9.1	-3.3	36.1	59.5	41.8	17.0
Ghana	0.9	7.9	-0.7	-6.8	1.2	162.3	279.7	170.3	135.7	0.9	7.9	-0.7	-6.8	1.2	162.3	279.7	170.3	135.7
Guinea	6.2	12.1	-0.1	-9.1	3.2	115.0	236.8	57.9	22.8	6.2	12.1	-0.1	-9.1	3.2	115.0	236.8	57.9	22.8
Guinea Bissau	2.1	8.4	0.2	-2.7	6.4	61.1	461.5	318.1	20.5	2.1	8.4	0.2	-2.7	6.4	61.1	461.5	318.1	20.5
Mali	-6.6	-1.3	-3.4	-12.1	-19.0	57.9	111.7	38.8	22.2	-6.6	-34.5	-1.8	-9.4	-11.3	408.5	857.3	389.2	372.9
Niger	-12.5	-8.7	-5.3	-13.9	-21.0	-8.1	6.8	0.1	-9.6	-12.5	-67.7	-5.3	-13.9	-21.0	-8.1	6.8	0.1	-9.6
Nigeria	0.2	7.0	-1.9	-9.2	-6.9	618.1	1555.8	118.3	87.9	0.2	4.6	-1.8	-8.5	-2.6	899.8	2673.1	243.7	238.3
Senegal	-26.1	-8.4	-5.8	-13.7	-19.7	-8.4	-0.4	-6.0	-8.7	-26.1	-31.7	-4.2	-10.0	-6.5	34.5	59.1	45.9	26.2
Togo	0.9	7.5	-0.9	-6.2	2.4	84.5	143.5	109.0	73.1	0.9	7.5	-0.9	-6.2	2.4	84.5	143.5	109.0	73.1
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	1.7	8.8	0.2	-5.1	3.2	101.6	416.9	284.3	114.9	1.7	8.8	0.2	-5.1	3.2	101.6	416.9	284.3	114.9
Burkina Faso	-6.7	-1.4	-3.3	-11.8	-18.4	52.8	97.2	44.7	26.7	-6.7	-1.4	-3.3	-11.8	-18.4	52.8	97.2	44.7	26.7
Cote d'Ivoire	0.5	7.3	-2.0	-7.0	1.3	234.9	522.0	43.4	19.3	0.5	7.3	-2.0	-7.0	1.3	234.9	522.0	43.4	19.3
Gambia	0.5	7.5	-2.1	-9.1	-3.3	36.1	59.5	41.8	17.0	0.5	7.5	-2.1	-9.1	-3.3	36.1	59.5	41.8	17.0
Ghana	0.9	7.9	-0.7	-6.8	1.2	162.3	279.7	170.3	135.7	0.9	7.9	-0.7	-6.8	1.2	162.3	279.7	170.3	135.7
Guinea	6.2	12.1	-0.1	-9.1	3.2	115.0	236.8	57.9	22.8	6.2	12.1	-0.1	-9.1	3.2	115.0	236.8	57.9	22.8
Guinea Bissau	2.1	8.4	0.2	-2.7	6.4	61.1	461.5	318.1	20.5	2.1	8.4	0.2	-2.7	6.4	61.1	461.5	318.1	20.5
Mali	-6.6	-1.3	-3.4	-12.1	-19.0	57.9	111.7	38.8	22.2	-6.6	-1.3	-3.4	-12.1	-19.0	57.9	111.7	38.8	22.2
Niger	-12.5	-8.7	-5.3	-13.9	-21.0	-8.1	6.8	0.1	-9.6	-12.5	-8.7	-5.3	-13.9	-21.0	-8.1	6.8	0.1	-9.6
Nigeria	0.2	7.0	-1.9	-9.2	-6.9	618.1	1555.8	118.3	87.9	0.2	7.0	-1.9	-9.2	-6.9	618.1	1555.8	118.3	87.9
Senegal	-26.1	-29.1	-5.8	-13.7	-19.7	-8.4	-0.4	-6.0	-8.7	-11.1	-8.4	-5.8	-13.7	-19.7	-8.4	-0.4	-6.0	-8.7
Togo	0.9	7.5	-0.9	-6.2	2.4	84.5	143.5	109.0	73.1	0.9	7.5	-0.9	-6.2	2.4	84.5	143.5	109.0	73.1

Table 28. Impact of climate change on cotton production under RCP8.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.9	6.5	-1.8	-5.8	32.8	102.3	415.1	357.0	116.0	0.9	6.5	-1.8	-5.8	32.8	102.3	415.1	357.0	116.0	
Burkina Faso	-31.5	-3.6	-7.5	-14.5	1.7	53.0	67.2	43.0	20.7	-8.8	-36.3	-4.3	-10.9	92.1	312.1	412.5	342.3	275.2	
Cote d'Ivoire	1.9	7.4	-1.9	-6.9	2.5	237.1	223.6	101.2	17.1	1.9	7.4	-1.9	-6.9	2.5	237.1	223.6	101.2	17.1	
Gambia	2.0	7.3	-2.3	-9.5	-1.1	37.9	64.8	41.9	17.2	2.0	7.3	-2.3	-9.5	-1.1	37.9	64.8	41.9	17.2	
Ghana	1.3	7.1	-1.5	-7.2	57.8	165.7	227.8	185.1	135.7	1.3	7.1	-1.5	-7.2	57.8	165.7	227.8	185.1	135.7	
Guinea	6.7	14.5	2.9	-6.7	5.0	114.7	141.0	88.8	37.9	6.7	14.5	2.9	-6.7	5.0	114.7	141.0	88.8	37.9	
Guinea Bissau	1.1	6.5	-1.6	-2.9	6.2	58.5	450.5	467.3	16.4	1.1	6.5	-1.6	-2.9	6.2	58.5	450.5	467.3	16.4	
Mali	-30.8	-3.4	-7.5	-14.9	-1.9	57.8	67.0	39.0	15.7	-8.6	-35.6	-4.3	-11.1	93.4	419.1	548.7	456.0	376.4	
Niger	-55.9	-11.5	-11.2	-17.4	-26.9	-10.2	-0.8	-7.0	-16.9	-16.3	-68.7	-11.2	-17.4	-26.9	-10.2	-0.8	-7.0	-16.9	
Nigeria	-0.5	6.6	-2.6	-10.2	21.4	627.5	627.3	299.4	85.8	1.2	4.2	-2.2	-9.1	36.0	914.5	1080.4	624.4	244.3	
Senegal	-39.1	-8.7	-10.9	-14.8	-19.5	-6.9	-4.2	-12.6	-16.8	-27.3	-31.8	-7.2	-10.5	-1.5	34.8	60.3	44.5	23.4	
Togo	1.4	7.3	-1.3	-6.3	28.0	85.2	140.0	116.1	71.8	1.4	7.3	-1.3	-6.3	28.0	85.2	140.0	116.1	71.8	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.9	6.5	-1.8	-5.8	32.8	102.3	415.1	357.0	116.0	0.9	6.5	-1.8	-5.8	32.8	102.3	415.1	357.0	116.0	
Burkina Faso	-31.5	-3.6	-7.5	-14.5	1.7	53.0	67.2	43.0	20.7	-8.8	-3.6	-7.5	-14.5	1.7	53.0	67.2	43.0	20.7	
Cote d'Ivoire	1.9	7.4	-1.9	-6.9	2.5	237.1	223.6	101.2	17.1	1.9	7.4	-1.9	-6.9	2.5	237.1	223.6	101.2	17.1	
Gambia	2.0	7.3	-2.3	-9.5	-1.1	37.9	64.8	41.9	17.2	2.0	7.3	-2.3	-9.5	-1.1	37.9	64.8	41.9	17.2	
Ghana	1.3	7.1	-1.5	-7.2	57.8	165.7	227.8	185.1	135.7	1.3	7.1	-1.5	-7.2	57.8	165.7	227.8	185.1	135.7	
Guinea	6.7	14.5	2.9	-6.7	5.0	114.7	141.0	88.8	37.9	6.7	14.5	2.9	-6.7	5.0	114.7	141.0	88.8	37.9	
Guinea Bissau	1.1	6.5	-1.6	-2.9	6.2	58.5	450.5	467.3	16.4	1.1	6.5	-1.6	-2.9	6.2	58.5	450.5	467.3	16.4	
Mali	-30.8	-3.4	-7.5	-14.9	-1.9	57.8	67.0	39.0	15.7	-8.6	-3.4	-7.5	-14.9	-1.9	57.8	67.0	39.0	15.7	
Niger	-55.9	-11.5	-11.2	-17.4	-26.9	-10.2	-0.8	-7.0	-16.9	-16.3	-11.5	-11.2	-17.4	-26.9	-10.2	-0.8	-7.0	-16.9	
Nigeria	-0.5	6.6	-2.6	-10.2	21.4	627.5	627.3	299.4	85.8	1.2	6.6	-2.6	-10.2	21.4	627.5	627.3	299.4	85.8	
Senegal	-39.1	-29.6	-10.9	-14.8	-19.5	-6.9	-4.2	-12.6	-16.8	-12.5	-8.7	-10.9	-14.8	-19.5	-6.9	-4.2	-12.6	-16.8	
Togo	1.4	7.3	-1.3	-6.3	28.0	85.2	140.0	116.1	71.8	1.4	7.3	-1.3	-6.3	28.0	85.2	140.0	116.1	71.8	

Depending on climate and socio-economic scenarios, only Senegal and Niger will exhibit a decrease in cotton production until the end of the century. All other countries will experience an increase in cotton production either before 2040 or by the end of the century depending on climate and socio-economic scenarios. The direction of the impacts also varies across ACZs. For example, both loamy and sandy soils in ACZ 17 experience a decrease in cotton production from 2020 to the end of the century under both moderate, and harsh climate change coupled with SSP1.

Cocoa, coffee, and sesame production

As reported in Table 29, countries in ECOWAS region will exhibit a decrease in production of cocoa, coffee, and sesame in all years except in 2050 and 2060 under the moderate climate change, regardless of socio-economic scenarios. This decrease ranges between 1-21.2 percent (with an average of 7.37 percent). Except Guinea, Liberia, Sierra Leone, and Togo, countries other countries in ECOWAS region will experience an increase in cocoa, coffee and sesame production in 2050 and 2060 ranging between 2-8.1 percent (with an average of 4.5), under the moderate climate and regardless of socio-economic scenarios. Under the harsh climate change, all countries in ECOWAS will exhibit a decrease in cocoa, coffee, and sesame production at the beginning of the study period (2020) and by the end of the century (2070, 2080, 2090 and 2100) and this will range between 1 and 17.1 percent (with an average of 9.2 percent), regardless of the socio-economic scenarios. For the other years, cocoa, coffee and sesame production in ECOWAS countries will either increase or decrease, with changes ranging between -6.9 percent and 7.9 percent (with an average of 2.1 percent), regardless of socio-economic scenarios. It appears that the negative impact of climate change on cocoa, coffee, and sesame production is moderate

under the hard climate than under the harsh climate change. The impacts of climate change on cocoa, coffee, and sesame production also vary across ACZs. For instance, clay soils in ACZ 22, and sandy soils in ACZ 33 experience an increase in cocoa, coffee, and sesame production under both moderate, and harsh climate change coupled with SSP1 from 2050 to 2065. Overall, the impacts of climate change vary across countries or across geographic units as predicted by a previous study (Mendelsohn *et al.*, 2006; Seo *et al.*, 2009; Medellin-Azuara *et al.*, 2011). Moreover, climate impacts do not differ only in terms of the direction of the impacts, but also in terms of the magnitude of the impacts.

Table 29. Impact of climate change on cocoa, coffee, and sesame production under RCP4.5

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	
Burkina Faso	-1.0	-2.3	-2.6	2.4	7.6	-1.3	-16.0	-11.6	-7.2	-1.0	-2.3	-2.6	2.4	7.6	-1.3	-16.0	-11.6	-7.2	
Cote d'Ivoire	-2.1	-0.4	-1.1	2.0	3.3	-6.4	-17.7	-12.2	-6.4	-2.1	-0.4	-1.1	2.0	3.3	-6.4	-17.7	-12.2	-6.4	
Gambia	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	
Ghana	-1.9	-0.3	-0.9	2.2	3.5	-6.1	-17.6	-12.0	-6.3	-1.9	-0.3	-0.9	2.2	3.5	-6.1	-17.6	-12.0	-6.3	
Guinea	-5.3	-2.7	-2.7	-1.0	-1.6	-11.0	-19.6	-12.4	-6.9	-5.3	-2.7	-2.7	-1.0	-1.6	-11.0	-19.6	-12.4	-6.9	
Liberia	-9.9	-5.6	-3.8	-3.9	-8.7	-14.9	-21.2	-10.3	-7.5	-9.9	-5.6	-3.8	-3.9	-8.7	-14.9	-21.2	-10.3	-7.5	
Mali	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	
Nigeria	-1.6	-0.1	-0.8	2.5	4.1	-5.5	-17.3	-12.2	-6.2	-1.6	-0.1	-0.8	2.5	4.1	-5.5	-17.3	-12.2	-6.2	
Senegal	-1.6	-1.8	-2.7	2.9	7.8	-1.2	-16.0	-11.6	-7.1	-1.6	-1.8	-2.7	2.9	7.8	-1.2	-16.0	-11.6	-7.1	
Sierra Leone	-10.1	-5.4	-3.8	-4.2	-8.4	-14.6	-20.7	-10.4	-7.3	-10.1	-5.4	-3.8	-4.2	-8.4	-14.6	-20.7	-10.4	-7.3	
Togo	-5.0	-2.7	-2.8	-0.4	-0.1	-9.7	-19.2	-12.6	-6.9	-5.0	-2.7	-2.8	-0.4	-0.1	-9.7	-19.2	-12.6	-6.9	
SSP3: Civil Society to the Rescue?										SSP4: Save Yourself									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	
Burkina Faso	-1.0	-2.3	-2.6	2.4	7.6	-1.3	-16.0	-11.6	-7.2	-1.0	-2.3	-2.6	2.4	7.6	-1.3	-16.0	-11.6	-7.2	
Cote d'Ivoire	-2.1	-0.4	-1.1	2.0	3.3	-6.4	-17.7	-12.2	-6.4	-2.1	-0.4	-1.1	2.0	3.3	-6.4	-17.7	-12.2	-6.4	
Gambia	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	
Ghana	-1.9	-0.3	-0.9	2.2	3.5	-6.1	-17.6	-12.0	-6.3	-1.9	-0.3	-0.9	2.2	3.5	-6.1	-17.6	-12.0	-6.3	
Guinea	-5.3	-2.7	-2.7	-1.0	-1.6	-11.0	-19.6	-12.4	-6.9	-5.3	-2.7	-2.7	-1.0	-1.6	-11.0	-19.6	-12.4	-6.9	
Liberia	-9.9	-5.6	-3.8	-3.9	-8.7	-14.9	-21.2	-10.3	-7.5	-9.9	-5.6	-3.8	-3.9	-8.7	-14.9	-21.2	-10.3	-7.5	
Mali	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	-2.3	-1.3	-2.8	3.4	8.1	-1.1	-16.0	-11.6	-7.1	
Nigeria	-1.6	-0.1	-0.8	2.5	4.1	-5.5	-17.3	-12.2	-6.2	-1.6	-0.1	-0.8	2.5	4.1	-5.5	-17.3	-12.2	-6.2	
Senegal	-1.6	-1.8	-2.7	2.9	7.8	-1.2	-16.0	-11.6	-7.1	-1.6	-1.8	-2.7	2.9	7.8	-1.2	-16.0	-11.6	-7.1	
Sierra Leone	-10.1	-5.4	-3.8	-4.2	-8.4	-14.6	-20.7	-10.4	-7.3	-10.1	-5.4	-3.8	-4.2	-8.4	-14.6	-20.7	-10.4	-7.3	
Togo	-5.0	-2.7	-2.8	-0.4	-0.1	-9.7	-19.2	-12.6	-6.9	-5.0	-2.7	-2.8	-0.4	-0.1	-9.7	-19.2	-12.6	-6.9	

Table 30. Impact of climate change on cocoa, coffee, and sesame production under RCP8.5

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3
Burkina Faso	-1.4	2.1	0.0	6.0	7.4	-0.4	-14.4	-11.7	-8.2	-1.4	2.1	0.0	6.0	7.4	-0.4	-14.4	-11.7	-8.2
Cote d'Ivoire	-1.7	2.4	0.0	5.1	5.4	-1.3	-14.7	-11.6	-6.7	-1.7	2.4	0.0	5.1	5.4	-1.3	-14.7	-11.6	-6.7
Gambia	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3
Ghana	-1.7	2.1	-0.2	4.9	5.4	-0.9	-14.2	-10.7	-6.0	-1.7	2.1	-0.2	4.9	5.4	-0.9	-14.2	-10.7	-6.0
Guinea	-2.8	3.3	0.4	3.5	2.1	-4.9	-17.1	-14.3	-8.7	-2.8	3.3	0.4	3.5	2.1	-4.9	-17.1	-14.3	-8.7
Liberia	-5.2	1.4	-1.4	-2.3	-3.8	-6.9	-15.8	-10.6	-7.1	-5.2	1.4	-1.4	-2.3	-3.8	-6.9	-15.8	-10.6	-7.1
Mali	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3
Nigeria	-1.5	2.3	-0.1	5.3	6.0	-0.6	-14.2	-10.9	-6.1	-1.5	2.3	-0.1	5.3	6.0	-0.6	-14.2	-10.9	-6.1
Senegal	-1.2	3.6	1.1	6.7	7.7	-0.1	-14.4	-11.8	-8.2	-1.2	3.6	1.1	6.7	7.7	-0.1	-14.4	-11.8	-8.2
Sierra Leone	-4.7	2.7	-0.7	-1.4	-2.8	-6.7	-15.8	-11.0	-7.8	-4.7	2.7	-0.7	-1.4	-2.8	-6.7	-15.8	-11.0	-7.8
Togo	-2.7	3.4	0.6	4.1	2.9	-4.4	-17.1	-14.5	-8.7	-2.7	3.4	0.6	4.1	2.9	-4.4	-17.1	-14.5	-8.7
SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3
Burkina Faso	-1.4	2.1	0.0	6.0	7.4	-0.4	-14.4	-11.7	-8.2	-1.4	2.1	0.0	6.0	7.4	-0.4	-14.4	-11.7	-8.2
Cote d'Ivoire	-1.7	2.4	0.0	5.1	5.4	-1.3	-14.7	-11.6	-6.7	-1.7	2.4	0.0	5.1	5.4	-1.3	-14.7	-11.6	-6.7
Gambia	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3
Ghana	-1.7	2.1	-0.2	4.9	5.4	-0.9	-14.2	-10.7	-6.0	-1.7	2.1	-0.2	4.9	5.4	-0.9	-14.2	-10.7	-6.0
Guinea	-2.8	3.3	0.4	3.5	2.1	-4.9	-17.1	-14.3	-8.7	-2.8	3.3	0.4	3.5	2.1	-4.9	-17.1	-14.3	-8.7
Liberia	-5.2	1.4	-1.4	-2.3	-3.8	-6.9	-15.8	-10.6	-7.1	-5.2	1.4	-1.4	-2.3	-3.8	-6.9	-15.8	-10.6	-7.1
Mali	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3	-1.0	5.0	2.2	7.5	7.9	0.0	-14.4	-11.8	-8.3
Nigeria	-1.5	2.3	-0.1	5.3	6.0	-0.6	-14.2	-10.9	-6.1	-1.5	2.3	-0.1	5.3	6.0	-0.6	-14.2	-10.9	-6.1
Senegal	-1.2	3.6	1.1	6.7	7.7	-0.1	-14.4	-11.8	-8.2	-1.2	3.6	1.1	6.7	7.7	-0.1	-14.4	-11.8	-8.2
Sierra Leone	-4.7	2.7	-0.7	-1.4	-2.8	-6.7	-15.8	-11.0	-7.8	-4.7	2.7	-0.7	-1.4	-2.8	-6.7	-15.8	-11.0	-7.8
Togo	-2.7	3.4	0.6	4.1	2.9	-4.4	-17.1	-14.5	-8.7	-2.7	3.4	0.6	4.1	2.9	-4.4	-17.1	-14.5	-8.7

Conclusion

This paper investigates the impacts of climate change on land allocation and crop production in ECOWAS zone. It adopts an approach based on environmental characteristics of Agro-Climatic and Soil Zones (ACSZs) to predict the impacts of climate change across ECOWAS landscape. Following Chang (2002), the methodology adopted involves a two-step procedure. In the first step, data on crop yields, climate, soil characteristics, and CO₂ concentration in the atmosphere were used to estimate yield response functions to environmental and climate conditions. These yield functions were then used to predict future crop yields following two RCPs (RCP4.5 and RCP8.5).

In the second step, the predicted yields were then incorporated into ECOLAND, a mathematical programming model for agricultural production with exogenous prices, to assess climate change impact on the agricultural land use and agricultural production in ECOWAS following four probable socio-economic conditions (SSPs). ECOLAND was calibrated following the traditional PMP approach to ensure that the model is able to replicate the observed cropland uses for 2004, our base year. The findings suggest that acreage will be lower, higher, or remains the same depending on the crops and the future conditions (combinations of climate and socio-economic scenarios). In terms of production, negative impacts, as well as positive, are observed. However, paddy rice, maize, sorghum, millet, oilseeds, cocoa, coffee, and sesame production experience a decrease in production under both moderate and harsh climate change in most of the cases. Thus, the study showed that acreage and crop production in ECOWAS countries are sensitive to climate change. Climate change will lead to a shift in land use for agricultural production within and among countries as a rational response

to its impact on crop yield by farmers seeking to maximize the profit of their farm activities. A structural transformation of the agricultural sector is, therefore, inevitable to offset the negative impacts of climate change to achieve a better level of livelihoods for the population. The findings are not uniform across countries, and ACZs, highlighting their disparities across geographic units.

Although the paper bring more lights on the impacts of climate change on agricultural land use and agricultural production in ECOWAS countries when most of the inefficiencies in crop production have to be removed, it does not investigate possible adaptation strategies to alleviate these impacts. However, our findings advocate for international/collective actions for reducing GHGs emissions as well as for developing adequate climate change adaptation strategies to improve the livelihood of people in developing countries of West Africa. Our modeling approach does not account for water scarcity as well as supply-induced price changes due to climate change. Including these factors could more or less affect the results of this paper. This will be investigated in future research.

References

- Attwood, J. D. et al., 2000. Assessing regional impacts of change: linking economic and environmental models. *Agricultural Systems*, 63(2000), pp. 147-159.
- Bamière, L. et al., 2011. Farming system modeling for agri-environmental policy design: The case of a spatially non-aggregated allocation of conservation measures. *Ecological Economics*, 70(2011), pp. 891-899.
- Barbier, B. & Bergeron, G., 1999. The impact of policy interventions on land management in Honduras: results of a bioeconomic model. *Agricultural Systems*, 60(1999), pp. 1-16.
- Bartolini, F. et al., 2007. The impact of water and agriculture policy scenarios on irrigated farming systems in Italy: An analysis based on farm level multi-attribute linear programming models. *Agricultural Systems*, 90(2007), pp. 90-114.
- Belhoucette, H. et al., 2011. Assessing the impact of the Nitrate Directive on farming systems using a bioeconomic modeling chain. *Agricultural Systems*, 104(2011), pp. 135-145.
- Butt, T. A. et al., 2005. The economic and food security implications of climate change in Mali. *Climatic Change*, 68(3), pp. 355-378.
- Cassamá, V. L. S., Atewamba, C. & Kouame, E., 2015. *Country profile on climate change, agricultural trade and food security in ECOWAS: Guinea-Bissau Report*, Accra: United Nations University - Institute for Natural Resources in Africa.
- Challinor, A. J. et al., 2014. A meta-analysis of crop yields under climate change and adaptation. *Nature Climate Change*, Volume 4, pp. 287-291.
- Chang, C.-C., 2002. The potential impact of climate changes on Taiwan's agriculture. *Agricultural Economics*, 27(2002), pp. 51-64.
- Chang, C.-C., McCarl, B. A., Mjelde, J. W. & Richardson, J. W., 1992. Sectoral Implications of Farm Program Modifications. *American Journal of Agricultural Economics*, 74(1), pp. 38-49.
- Chen, X., Huang, H., Khanna, M. & Önal, H., 2014. Alternative transportation fuel standards: Welfare effects and climate benefits. *Journal of Environmental Economics and Management*, 67(2014), pp. 241-257.
- Cortignani, R. & Severini, S., 2009. Modeling farm-level adoption of deficit irrigation using Positive Mathematical Programming. *Agricultural Water Management*, 96(2009), pp. 1785-1791.

- Di Falco, S., Yesuf, M., Kohlin, G. & Ringler, C., 2012. Estimating the Impact of Climate Change on Agriculture in Low-Income Countries: Household Level Evidence from the Nile Basin, Ethiopia. *Environ Resource Econ*, 52(2012), pp. 457-478.
- Dolisca, F., McDaniel, J. M., Shannon, D. A. & Jolly, C. M., 2008. Modeling farm households for estimating the efficiency of policy instruments on sustainable land use in Haiti. *Land Use Policy*, 26(2008), pp. 130-138.
- Du, X., Yu, C. L., Hennessy, D. A. & Miao, R., 2015. Geography of crop yields skewness. *Agricultural Economics*, 46(2015), pp. 463-473.
- Egbindewe-Mondzozo, A., Swinton, S. M., Bals, B. D. & Dale, B. E., 2013. Can Dispersed Biomass Processing Protect the Environment and Cover the Bottom Line for Biofuel?. *Environmental Science & Technology*, Volume 47, pp. 1695-1703.
- Egbindewe-Mondzozo, A. et al., 2011. Biomass supply from alternative cellulosic crops and crop residues: A spatially explicit bioeconomic modeling approach. *Biomass and Bioenergy*, 35(2011), pp. 4636-4647.
- Egbindewe-Mondzozo, A. et al., 2015. Bioenergy Supply and Environmental Impacts on Cropland: Insights from Multi-market Forecasts in a Great Lakes Subregional Bioeconomic Model. *Applied Economic Perspectives and Policy*, pp. 1-17.
- FAO, 2015. Land use systems of the world - Sub-Saharan Africa.. [Online] Available at: <http://www.fao.org/geonetwork/srv/en/metadata.show?id=37048> [Accessed 30 11 2015].
- FAO, 2015b. FAOSTAT, Rome: Food and Agriculture Organization of the United Nations.
- Fischer, G., Shah, M., Tubiello, F. N. & van Velhuizen, H., 2005. Socio-Economic and Climate Change Impacts on Agriculture: An Integrated Assessment, 1990-2080. *Phil. Trans. R. Soc. B*, 360(1463), pp. 2067-2083.
- Gornall, J. et al., 2010. Implications of climate change for agricultural productivity in the early twenty-first century. *Phil. Trans. R. Soc. B*, 365(2010), p. 2973–2989.
- Hazell, P. & Norton, R., 1986. *Mathematical programming for economic analysis in agriculture*. New York: MacMillan.
- Heckelei, T., Britz, W. & Zhang, Y., 2012. Positive Mathematical Programming Approaches – Recent Developments in Literature and Applied Modelling. *Bio-based and Applied Economics*, 1(1), pp. 109-124.

Hellwinckel, C. M., West, T. O., de la Torre Ugarte, D. G. & Perlack, R. D., 2010. Evaluating possible cap and trade legislation on cellulosic feedstock availability. *GCB Bioenergy*, Volume 2, pp. 278-287.

Howitt, R. E., 1995a. Positive Mathematical Programming. *American Journal of Agricultural Economics*, 77(2), pp. 329-342.

Howitt, R., Medellin-Azuara, J. & MacEwan, D., 2009. *Estimating the economic impacts of agricultural yield-related changes for California*, California: California Climate Change Center.

IPCC, 2014a. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. The contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC, 2014b. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. The contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Jalloh, A. et al., 2013. Overview. In: *West African Agriculture and Climate Change, A Comprehensive Analysis*. Washington D.C.: The International Food Policy Research Institute, pp. 1-35.

Janssen, S. et al., 2010. A Generic Bio-Economic Farm Model for Environmental and Economic Assessment of Agricultural Systems. *Environmental Management*, 46(2010), pp. 862-877.

Judez, L., Chaya, C., Martinez, S. & Gonzalez, A. A., 2001. Effects of the measures envisaged in "Agenda 2000" on arable crop producers and beef and veal producers: an application of Positive Mathematical Programming to the representative farm of a Spanish region. *Agricultural Systems*, 67(2001), pp. 121-138.

Kanellopoulos, A. et al., 2010. Assessing the Forecasting Performance of a Generic Bio-Economic Farm Model Calibrated With Two Different PMP Variants. *Journal of Agricultural Economics*, 61(2), pp. 274-294.

Kaufmann, R. K. & Snell, S. E., 1997. A Biophysical Model of Corn Yield: Integrating Climatic and Social Determinants. *American Journal of Agricultural Economics*, 79(1), pp. 178-190.

- Khanna, M., Chen, X., Huang, H. & Onal, H., 2011. Supply of Cellulosic Biofuel Feedstocks and Regional Production Patterns. *Amer. J. Agr. Econ.*, 93(2), pp. 473-480.
- Kutcher, G. P. & Scandizzo, P. L., 1981. *The Agricultural Economy of Northeast Brazil*. Baltimore and London: The Johns Hopkins University Press.
- Leclère, D. et al., 2014. Climate change induced transformations of agricultural systems: insights from a global model. *Environmental Research Letters*, 9(2014), pp. 1-14.
- Lokonon, B. O. K., Savadogo, K. & Mbaye, A. A., 2015. Assessing the impacts of climate shocks on farm performance and adaptation responses in the Niger basin of Benin. *African Journal of Agricultural and Resource Economics*, 10(3), pp. 234-249.
- Louhichi, K., Flichman, G. & Boisson, J. M., 2010b. Bioeconomic modeling of soil erosion externalities and policy options: a Tunisian case study. *J Bioecon*, 12(2010), pp. 145-167.
- Louhichi, K. et al., 2010a. FSSIM, a bio-economic farm model for simulating the response of EU farming systems to agricultural and environmental policies. *Agricultural Systems*, 103(2010), pp. 585-597.
- Louhichi, K. & Paloma, S. G., 2014. A farm household model for agri-food policy analysis in developing countries: Application to smallholder farmers in Sierra Leone. *Food Policy*, 45(2014), pp. 1-13.
- Louhichi, K. et al., 2013. *Modelling Agri-Food Policy Impact at Farm-household Level in Developing Countries (FSSIM-Dev): Application to Sierra Leone*. Seville: Luxembourg: Publications Office of the European Union.
- Maman, N. M. M., Atewamba, C. & Kouame, E., 2015. *Profile pays sur les changements climatiques, le commerce agricole et la securite alimentaire dans la CEDEAO: Rapport du Niger*, Accra: United Nations University - Institute for Natural Resources in Africa.
- McCarl, B. A. & Spreen, T. H., 1980. Price Endogenous Mathematical Programming as a Tool for Sector Analysis. *American Journal of Agricultural Economics*, 62(1), pp. 87-102.
- McCarl, B. A., Villavicencio, X. & Wu, X., 2008. Climate Change and Future Analysis: Is Stationarity Dying. *American Journal of Agricultural Economics*, 90(5), pp. 1241-1247.

- Medellin-Azuara, J., Howitt, R. E., MacEwan, D. J. & Lund, J. R., 2011. Economic impacts of climate-related changes to California agriculture. *Climatic Change*, 109(Suppl 1), pp. S387-S405.
- Mendelsohn, R., Dinar, A. & Williams, L., 2006. The distributional impact of climate change on rich and poor countries. *Environment and Development Economics*, Volume 11, pp. 159-178.
- Mendelsohn, R., Nordhaus, W. & Shaw, D., 1996. Climate impacts on aggregate farm value: accounting for adaptation. *Agricultural and Forest Meteorology*, 80(1996), pp. 55-66.
- Nelson, G. C. et al., 2010. *Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options*, Washington, D.C.: Library of Congress Cataloging-in-Publication Data.
- Palazzo, A. et al., 2014. *Simulating stakeholder-driven food and climate scenarios for policy development in Africa, Asia, and Latin America: A multi-regional synthesis*, Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture, CCAFS Working Paper no. 109.
- Paloma, G. S. et al., 2012. *Rural poverty reduction and food security: The case of smallholders in Sierra Leone*. Seville: Luxembourg: Publications Office of the European Union.
- Parry, L. M. et al., 2004. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change*, 14(2004), pp. 53-67.
- Pinky, S. B. & Rayhan, M. I., 2013. Climate change impact on crop productivity: a bioeconomic analysis. *Bulletin of Environmental and Scientific Research*, 2(4), pp. 11-15.
- Ray, D. K., Mueller, N. D., West, P. C. & Foley, J. A., 2013. Yield Trends Are Insufficient to Double Global Crop Production by 2050. *PLoS ONE*, 8(6), pp. 1-8.
- Rhodes, E. R., Atewamba, C. & Kouame, E., 2015. *Country profile on climate change, agricultural trade and food security in ECOWAS: Sierra Leone Report*, Accra: United Nations University - Institute for Natural Resources in Africa.
- Rohm, O. & Dabbert, S., 2003. Integrating Agri-Environmental Programs into Regional Production Models: An Extension of Positive Mathematical Programming. *American Journal of Agricultural Economics*, 85(1), pp. 254-265.

- Rosenzweig, C. et al., 2014. Assessing agricultural risks of climate change in the 21st century in a global gridded crop model intercomparison. *PNAS*, 111(9), p. 3268–3273.
- Roudier, P., Sultan, B., Quirion, P. & Berg, A., 2011. The impact of future climate change on West African crop yields: What does the recent literature say?. *Global Environmental Change*, 21(2011), p. 1073–1083.
- Sanchez, P. A. & Swaminathan, M. S., 2005. Hunger in Africa: the link between unhealthy people and unhealthy soils. *Lancet*, Volume 365, pp. 442-444.
- Sanfo, S. & Gérard, F., 2012. Public policies for rural poverty alleviation: The case of agricultural households in the Plateau Central area of Burkina Faso. *Agricultural Systems*, 110(2012), pp. 1-9.
- Segerson, K. & Dixon, B. L., 1999. Climate change and agriculture: the role of farmer adaptation. In: R. Mendelsohn & J. E. Neumann, eds. *The Impact of Climate Change on the United States Economy*. Cambridge: Cambridge University Press, pp. 75-93.
- Seo, N. S., 2013. An essay on the impact of climate change on US agriculture: weather fluctuations, climatic shifts, and adaptation strategies. *Climatic Change*, 121(2013), pp. 115-124.
- Seo, N. S. & Mendelsohn, R., 2008a. Animal husbandry in Africa: Climate change impacts and adaptations. *African Journal of Agricultural and Resource Economics*, 2(1), pp. 65-82.
- Seo, N. S. & Mendelsohn, R., 2008b. Measuring impacts and adaptations to climate change: a structural Ricardian model of African livestock management. *Agricultural Economics*, 38(2008), p. 151–165.
- Seo, N. S. et al., 2009. A Ricardian Analysis of the Distribution of Climate Change Impacts on Agriculture across Agro-Ecological Zones in Africa. *Environ Resource Econ*, 43(2009), pp. 313-332.
- Sowe, M., 2015. *Country profile on climate change, agricultural trade and food security in ECOWAS: The Gambia Report*, Accra: United Nations University - Institute for Natural Resources in Africa.
- Spreen, T. H., 2006. Price Endogenous Mathematical Programming Models and Trade Analysis. *Journal of Agricultural and Applied Economics*, 38(2), pp. 249-253.

Sylla, B. M., 2015. *Development and Analysis of Climatological Baseline and Climate Change Scenarios for ECOWAS*, Accra: United Nations University Institute for Natural Resources in Africa (UNU-INRA).

Tol, R. S. J., 2002. Estimates of the Damage Costs of Climate Change. Part 1: Benchmark Estimates. *Environmental and Resource Economics*, Volume 21, pp. 47-73.

UNU-INRA, 2014. *Modelling Climate Change, Agricultural Trade and Food Security in ECOWAS*, Accra: United Nations University-Institute for Natural Resources in Africa.

van Wart, J. et al., 2013. Use of agro-climatic zones to upscale simulated crop yield potential. *Field Crops Research*, 143(2013), pp. 44-55.

von Lampe, M. et al., 2014. Why do global long-term scenarios for agriculture differ? An overview of the AgMIP Global Economic Model Intercomparison. *Agricultural Economics*, 45(2014), pp. 3-20.

Wilkinson, A. & Eidinow, E., 2008. Evolving practices in environmental scenarios: a new scenario typology. *Environmental Research Letters*, 3(2008), pp. 1-11.

Williams, J., Hook, R. A. & Hamblin, A., 2002. *Agro-Ecological regions of Australia: Methodology for their derivation and key issues in resource management*, Canberra: CSIRO Land and Water.

World Bank, 2015. *World Development Indicators Database*, Washington DC: World Bank.

Yilma, T. D., 2005. *Modeling farm irrigation decisions under rainfall risk in the White-Volta basin of Ghana: A tool for policy analysis at the farm-household level*, Bonn: University of Bonn.

Appendices

Appendix 1. Paddy rice acreage without climate change (1,000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	34.0	41.4	50.5	51.4	60.1	72.1	86.1	103.4	123.3	34.0	41.4	50.5	51.4	60.1	72.1	86.1	103.4	123.3
Burkina Faso	68.0	82.9	101.0	120.2	145.8	177.5	216.2	263.4	319.9	68.0	82.9	101.0	120.2	145.8	177.5	216.2	263.4	319.9
Cote d'Ivoire	468.1	570.6	693.7	777.4	916.8	1089.0	1280.8	1431.5	1507.4	468.1	570.6	693.7	777.4	916.8	1089.0	1280.8	1431.5	1507.4
Gambia	7.1	8.7	10.6	12.9	15.7	19.1	23.3	25.5	26.7	7.1	8.7	10.6	12.9	15.7	19.1	23.3	25.5	26.7
Ghana	163.9	199.8	243.5	275.7	330.4	391.1	441.8	452.0	433.6	163.9	199.8	243.5	275.7	330.4	391.1	441.8	452.0	433.6
Guinea	948.7	1156.5	1406.9	1687.1	2021.2	2360.6	2555.0	2496.8	2418.0	948.7	1156.5	1406.9	1687.1	2021.2	2360.6	2555.0	2496.8	2418.0
Guinea Bissau	89.2	108.8	130.6	157.1	180.4	198.3	209.0	214.6	217.5	89.2	108.8	130.6	157.1	180.4	198.3	209.0	214.6	217.5
Liberia	64.6	78.8	96.0	117.0	142.7	168.7	180.5	167.2	150.9	64.6	78.8	96.0	117.0	142.7	168.7	180.5	167.2	150.9
Mali	132.7	161.8	197.2	239.4	291.6	355.4	433.2	528.1	639.2	132.7	161.8	197.2	239.4	291.6	355.4	433.2	528.1	639.2
Niger	32.1	39.1	47.7	58.1	70.9	86.4	105.3	128.4	156.5	32.1	39.1	47.7	58.1	70.9	86.4	105.3	128.4	156.5
Nigeria	3223.3	3877.7	4651.0	5291.6	6203.1	7120.1	7631.5	8008.3	8112.8	3223.3	3877.7	4651.0	5291.6	6203.1	7120.1	7631.5	8008.3	8112.8
Senegal	111.9	136.4	166.2	202.2	246.3	300.2	365.9	431.2	504.2	111.9	136.4	166.2	202.2	246.3	300.2	365.9	431.2	504.2
Sierra Leone	621.7	757.8	923.8	1126.0	1372.6	1583.3	1518.3	1345.6	1129.4	621.7	757.8	923.8	1126.0	1372.6	1583.3	1518.3	1345.6	1129.4
Togo	44.3	54.0	65.7	77.0	92.0	110.6	133.1	152.9	174.5	44.3	54.0	65.7	77.0	92.0	110.6	133.1	152.9	174.5
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	34.0	41.4	50.5	51.4	60.1	72.1	86.1	103.4	123.3	34.0	41.4	50.5	51.4	60.1	72.1	86.1	103.4	123.3
Burkina Faso	68.0	82.9	101.0	120.2	145.8	177.5	216.2	263.4	319.9	68.0	82.9	101.0	120.2	145.8	177.5	216.2	263.4	319.9
Cote d'Ivoire	468.1	570.6	693.7	777.4	916.8	1089.0	1280.8	1431.5	1507.4	468.1	570.6	693.7	777.4	916.8	1089.0	1280.8	1431.5	1507.4
Gambia	7.1	8.7	10.6	12.9	15.7	19.1	23.3	25.5	26.7	7.1	8.7	10.6	12.9	15.7	19.1	23.3	25.5	26.7
Ghana	163.9	199.8	243.5	275.7	330.4	391.1	441.8	452.0	433.6	163.9	199.8	243.5	275.7	330.4	391.1	441.8	452.0	433.6
Guinea	948.7	1156.5	1406.9	1687.1	2021.2	2360.6	2555.0	2496.8	2418.0	948.7	1156.5	1406.9	1687.1	2021.2	2360.6	2555.0	2496.8	2418.0
Guinea Bissau	89.2	108.8	130.6	157.1	180.4	198.3	209.0	214.6	217.5	89.2	108.8	130.6	157.1	180.4	198.3	209.0	214.6	217.5
Liberia	64.6	78.8	96.0	117.0	142.7	168.7	180.5	167.2	150.9	64.6	78.8	96.0	117.0	142.7	168.7	180.5	167.2	150.9
Mali	132.7	161.8	197.2	239.4	291.6	355.4	433.2	528.1	639.2	132.7	161.8	197.2	239.4	291.6	355.4	433.2	528.1	639.2
Niger	32.1	39.1	47.7	58.1	70.9	86.4	105.3	128.4	156.5	32.1	39.1	47.7	58.1	70.9	86.4	105.3	128.4	156.5
Nigeria	3223.3	3877.7	4651.0	5291.6	6203.1	7120.1	7631.5	8008.3	8112.8	3223.3	3877.7	4651.0	5291.6	6203.1	7120.1	7631.5	8008.3	8112.8
Senegal	111.9	136.4	166.2	202.2	246.3	300.2	365.9	431.2	504.2	111.9	136.4	166.2	202.2	246.3	300.2	365.9	431.2	504.2
Sierra Leone	621.7	757.8	923.8	1126.0	1372.6	1583.3	1518.3	1345.6	1129.4	621.7	757.8	923.8	1126.0	1372.6	1583.3	1518.3	1345.6	1129.4
Togo	44.3	54.0	65.7	77.0	92.0	110.6	133.1	152.9	174.5	44.3	54.0	65.7	77.0	92.0	110.6	133.1	152.9	174.5

Appendix 2. Cereals acreage without climate change (1,000,000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100		
Benin	1.3	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.8	1.2	1.5	1.7	1.9	2.1	2.2	2.4	2.3	2.3		
Burkina Faso	3.9	4.9	5.8	6.9	7.7	8.2	8.8	9.5	10.4	3.4	4.7	5.6	6.6	7.3	7.8	8.4	7.3	3.1		
Cote d'Ivoire	0.5	0.6	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.5	0.6	0.6	0.5	0.4	0.3	0.2	0.2	0.2		
Gambia	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.4	0.2		
Ghana	1.1	1.3	1.4	1.5	1.5	1.4	1.3	1.2	1.2	1.1	1.3	1.4	1.5	1.5	1.4	1.3	1.2	1.1		
Guinea	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3		
Guinea Bissau	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Mali	3.5	4.6	5.4	6.2	6.8	7.2	7.6	8.0	8.5	3.1	3.9	4.6	5.2	5.6	5.9	6.3	5.6	2.7		
Niger	7.2	10.3	9.6	8.7	7.7	6.7	6.8	6.9	7.1	7.0	6.7	6.5	6.2	6.1	6.1	6.2	2.8	1.7		
Nigeria	17.0	19.9	22.2	23.9	24.6	24.2	24.1	24.2	24.4	16.2	19.2	21.3	22.7	23.1	22.7	22.6	21.0	13.0		
Senegal	1.1	1.4	1.7	2.0	2.4	2.5	2.7	2.9	3.2	0.9	1.1	1.3	1.4	1.6	1.8	2.0	1.8	0.8		
Sierra Leone	0.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1		
Togo	0.4	0.5	0.6	0.7	0.8	0.8	0.8	0.8	0.9	0.4	0.5	0.6	0.7	0.8	0.8	0.8	0.8	0.9		
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself									
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100		
Benin	1.2	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.8	1.3	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.8		
Burkina Faso	3.4	4.9	5.8	6.9	7.7	8.2	8.8	9.5	10.4	4.0	4.9	5.8	6.9	7.7	8.2	8.8	9.5	10.4		
Cote d'Ivoire	0.5	0.6	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.5	0.6	0.6	0.5	0.4	0.3	0.2	0.2	0.2		
Gambia	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6		
Ghana	1.1	1.3	1.4	1.5	1.5	1.4	1.3	1.2	1.2	1.1	1.3	1.4	1.5	1.5	1.4	1.3	1.2	1.2		
Guinea	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3		
Guinea Bissau	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Mali	3.1	4.6	5.4	6.2	6.8	7.2	7.6	8.0	8.5	3.8	4.6	5.4	6.2	6.8	7.2	7.6	8.0	8.5		
Niger	7.0	10.3	9.6	8.7	7.7	6.7	6.8	6.9	7.1	9.7	10.3	9.6	8.7	7.7	6.7	6.8	6.9	7.1		
Nigeria	16.3	19.9	22.2	23.9	24.6	24.2	24.1	24.2	24.4	17.4	19.9	22.2	23.9	24.6	24.2	24.1	24.2	24.4		
Senegal	0.9	1.4	1.7	2.0	2.4	2.5	2.7	2.9	3.2	1.2	1.4	1.7	2.0	2.4	2.5	2.7	2.9	3.2		
Sierra Leone	0.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1		
Togo	0.4	0.5	0.6	0.7	0.8	0.8	0.8	0.8	0.9	0.4	0.5	0.6	0.7	0.8	0.8	0.8	0.8	0.9		

Appendix 3. Vegetable, and fruits acreage without climate change (1,000,000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
Burkina Faso	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Cote d'Ivoire	1.8	2.2	2.6	3.2	3.7	4.3	4.9	5.1	5.4	1.8	2.2	2.6	3.2	3.7	4.3	4.9	5.1	5.4
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	2.0	2.4	3.0	3.6	4.3	5.2	6.0	6.1	6.3	2.0	2.4	3.0	3.6	4.3	5.2	6.0	6.1	6.3
Guinea	0.5	0.6	0.6	0.7	0.8	1.0	1.1	1.3	1.5	0.5	0.6	0.6	0.7	0.8	1.0	1.1	1.3	1.5
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Liberia	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Nigeria	10.8	12.3	13.8	15.4	16.7	18.2	19.7	20.9	22.3	10.8	12.3	13.8	15.4	16.7	18.2	19.7	20.9	22.3
Senegal	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sierra Leone	0.4	0.5	0.6	0.8	0.9	1.2	1.4	1.7	2.1	0.4	0.5	0.6	0.8	0.9	1.2	1.4	1.7	2.1
Togo	0.2	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.2	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
Burkina Faso	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Cote d'Ivoire	1.8	2.2	2.6	3.2	3.7	4.3	4.9	5.1	5.4	1.8	2.2	2.6	3.2	3.7	4.3	4.9	5.1	5.4
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	2.0	2.4	3.0	3.6	4.3	5.2	6.0	6.1	6.3	2.0	2.4	3.0	3.6	4.3	5.2	6.0	6.1	6.3
Guinea	0.5	0.6	0.6	0.7	0.8	1.0	1.1	1.3	1.5	0.5	0.6	0.6	0.7	0.8	1.0	1.1	1.3	1.5
Guinea Bissau	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Liberia	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Nigeria	10.8	12.3	13.8	15.4	16.7	18.2	19.7	20.9	22.3	10.8	12.3	13.8	15.4	16.7	18.2	19.7	20.9	22.3
Senegal	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sierra Leone	0.4	0.5	0.6	0.8	0.9	1.2	1.4	1.7	2.1	0.4	0.5	0.6	0.8	0.9	1.2	1.4	1.7	2.1
Togo	0.2	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.2	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6

Appendix 4. Oil seeds acreage without climate change (100,000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	6.5	7.9	9.6	11.8	14.3	17.3	18.3	17.4	14.5	6.5	7.9	9.6	11.8	14.3	17.3	18.3	17.3	14.4	
Burkina Faso	4.6	5.6	6.9	8.2	9.8	11.6	13.4	15.7	16.6	4.6	5.6	6.3	7.5	8.5	10.3	13.1	13.0	13.7	
Cote d'Ivoire	6.9	8.3	9.2	9.6	9.5	8.0	6.2	3.9	1.9	6.9	8.3	9.2	9.6	9.5	8.0	6.2	3.9	1.9	
Gambia	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.1	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.1	
Ghana	6.5	7.9	8.7	8.1	7.1	6.5	5.8	5.0	3.8	6.5	7.9	8.7	8.1	7.1	6.5	5.8	5.0	3.8	
Guinea	2.6	3.2	3.7	3.8	3.5	3.1	2.6	2.1	1.5	2.6	3.2	3.7	3.8	3.5	3.1	2.6	2.1	1.5	
Guinea Bissau	2.1	2.5	2.7	2.9	2.9	3.0	3.0	2.8	2.6	2.1	2.5	2.7	2.9	2.9	3.0	3.0	2.8	2.6	
Liberia	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
Mali	7.6	9.2	11.2	13.3	15.4	17.7	18.1	18.1	18.2	7.6	9.2	7.2	7.9	6.2	8.9	15.8	4.3	3.0	
Niger	42.4	51.7	63.0	76.3	91.7	105.2	107.4	108.8	109.9	42.4	51.7	57.0	66.1	33.6	91.9	103.9	55.7	33.4	
Nigeria	93.6	103.7	110.9	116.6	115.6	114.4	112.4	111.8	108.5	93.6	103.7	103.6	106.7	100.9	98.3	108.2	70.5	65.7	
Senegal	8.1	9.8	12.0	14.3	16.9	19.9	20.6	20.6	20.5	8.1	9.8	4.9	4.8	4.4	4.3	16.3	1.4	1.2	
Sierra Leone	1.6	2.0	2.3	2.7	1.2	1.0	0.9	0.8	0.8	1.6	2.0	2.3	2.7	1.2	1.0	0.9	0.8	0.8	
Togo	3.0	3.7	4.3	4.8	5.4	5.6	5.4	4.9	4.2	3.0	3.7	4.3	4.8	5.4	5.6	5.4	4.9	4.2	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	6.5	7.9	9.6	11.8	14.3	17.3	18.3	17.4	14.5	6.5	7.9	9.6	11.8	14.3	17.3	18.3	17.4	14.5	
Burkina Faso	4.6	5.6	6.9	8.2	9.8	11.6	13.4	15.7	16.6	4.6	5.6	6.9	8.2	9.8	11.6	13.4	15.7	16.6	
Cote d'Ivoire	6.9	8.3	9.2	9.6	9.5	8.0	6.2	3.9	1.9	6.9	8.3	9.2	9.6	9.5	8.0	6.2	3.9	1.9	
Gambia	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.1	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.1	
Ghana	6.5	7.9	8.7	8.1	7.1	6.5	5.8	5.0	3.8	6.5	7.9	8.7	8.1	7.1	6.5	5.8	5.0	3.8	
Guinea	2.6	3.2	3.7	3.8	3.5	3.1	2.6	2.1	1.5	2.6	3.2	3.7	3.8	3.5	3.1	2.6	2.1	1.5	
Guinea Bissau	2.1	2.5	2.7	2.9	2.9	3.0	3.0	2.8	2.6	2.1	2.5	2.7	2.9	2.9	3.0	3.0	2.8	2.6	
Liberia	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
Mali	7.6	9.2	11.2	13.3	15.4	17.7	18.1	18.1	18.2	7.6	9.2	11.2	13.3	15.4	17.7	18.1	18.1	18.2	
Niger	42.4	51.7	63.0	76.3	91.7	105.2	107.4	108.8	109.9	42.4	51.7	63.0	76.3	91.7	105.2	107.4	108.8	109.9	
Nigeria	93.6	103.7	110.9	116.6	115.6	114.4	112.4	111.8	108.5	93.6	103.7	110.9	116.6	115.6	114.4	112.4	111.8	108.5	
Senegal	8.1	9.8	12.0	14.3	16.9	19.9	20.6	20.6	20.5	8.1	9.8	12.0	14.3	16.9	19.9	20.6	20.6	20.5	
Sierra Leone	1.6	2.0	2.3	2.7	1.2	1.0	0.9	0.8	0.8	1.6	2.0	2.3	2.7	1.2	1.0	0.9	0.8	0.8	
Togo	3.0	3.7	4.3	4.8	5.4	5.6	5.4	4.9	4.2	3.0	3.7	4.3	4.8	5.4	5.6	5.4	4.9	4.2	

Appendix 5. Sugarcane acreage without climate change (1000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	2.6	3.2	3.9	4.8	5.8	7.1	8.7	10.6	12.9	2.6	3.2	3.9	4.8	5.8	7.1	8.7	10.6	12.9	
Burkina Faso	5.0	6.1	7.4	9.0	11.0	13.4	15.2	16.5	18.2	5.0	6.1	7.4	9.0	11.0	13.4	15.2	16.5	18.2	
Cote d'Ivoire	31.6	38.5	47.0	57.3	66.6	72.7	80.2	89.2	100.2	31.6	38.5	47.0	57.3	66.6	72.7	80.2	89.2	100.2	
Ghana	7.6	9.2	11.2	13.7	16.2	18.6	20.0	20.5	21.2	7.6	9.2	11.2	13.7	16.2	18.6	20.0	20.5	21.2	
Guinea	7.1	8.7	10.6	12.9	15.8	19.2	23.4	28.5	34.7	7.1	8.7	10.6	12.9	15.8	19.2	23.4	28.5	34.7	
Guinea Bissau	0.3	0.3	0.4	0.5	0.6	0.4	0.5	0.6	0.8	0.3	0.3	0.4	0.5	0.6	0.4	0.5	0.6	0.8	
Liberia	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.8	1.0	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.8	1.0	
Mali	6.1	7.5	9.1	11.1	13.5	16.5	20.1	24.5	29.9	6.1	7.5	9.1	11.1	13.5	16.5	20.1	24.5	29.9	
Niger	5.2	6.4	7.8	9.4	11.5	14.0	17.1	20.9	25.4	5.2	6.4	7.8	9.4	11.5	14.0	17.1	20.9	25.4	
Nigeria	39.5	33.4	32.3	32.4	33.9	36.7	40.9	46.8	54.5	39.5	33.4	32.3	32.4	33.9	36.7	40.9	46.8	54.5	
Senegal	9.7	11.9	14.5	17.6	21.5	26.2	31.4	37.5	45.0	9.7	11.9	14.5	17.6	21.5	26.2	30.5	36.4	33.0	
Sierra Leone	1.4	1.7	2.0	2.5	3.0	3.5	4.3	5.2	6.4	1.4	1.7	2.0	2.5	3.0	3.5	4.3	5.2	6.4	
Togo	1.2	1.5	1.8	2.2	2.7	3.3	4.1	4.9	6.0	1.2	1.5	1.8	2.2	2.7	3.3	4.1	4.9	6.0	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	2.6	3.2	3.9	4.8	5.8	7.1	8.7	10.6	12.9	2.6	3.2	3.9	4.8	5.8	7.1	8.7	10.6	12.9	
Burkina Faso	5.0	6.1	7.4	9.0	11.0	13.4	15.2	16.5	18.2	5.0	6.1	7.4	9.0	11.0	13.4	15.2	16.5	18.2	
Cote d'Ivoire	31.6	38.5	47.0	57.3	66.6	72.7	80.2	89.2	100.2	31.6	38.5	47.0	57.3	66.6	72.7	80.2	89.2	100.2	
Ghana	7.6	9.2	11.2	13.7	16.2	18.6	20.0	20.5	21.2	7.6	9.2	11.2	13.7	16.2	18.6	20.0	20.5	21.2	
Guinea	7.1	8.7	10.6	12.9	15.8	19.2	23.4	28.5	34.7	7.1	8.7	10.6	12.9	15.8	19.2	23.4	28.5	34.7	
Guinea Bissau	0.3	0.3	0.4	0.5	0.6	0.4	0.5	0.6	0.8	0.3	0.3	0.4	0.5	0.6	0.4	0.5	0.6	0.8	
Liberia	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.8	1.0	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.8	1.0	
Mali	6.1	7.5	9.1	11.1	13.5	16.5	20.1	24.5	29.9	6.1	7.5	9.1	11.1	13.5	16.5	20.1	24.5	29.9	
Niger	5.2	6.4	7.8	9.4	11.5	14.0	17.1	20.9	25.4	5.2	6.4	7.8	9.4	11.5	14.0	17.1	20.9	25.4	
Nigeria	39.5	33.4	32.3	32.4	33.9	36.7	40.9	46.8	54.5	39.5	33.4	32.3	32.4	33.9	36.7	40.9	46.8	54.5	
Senegal	9.7	11.9	14.5	17.6	21.5	26.2	31.4	37.5	45.0	9.7	11.9	14.5	17.6	21.5	26.2	31.4	37.5	45.0	
Sierra Leone	1.4	1.7	2.0	2.5	3.0	3.5	4.3	5.2	6.4	1.4	1.7	2.0	2.5	3.0	3.5	4.3	5.2	6.4	
Togo	1.2	1.5	1.8	2.2	2.7	3.3	4.1	4.9	6.0	1.2	1.5	1.8	2.2	2.7	3.3	4.1	4.9	6.0	

Appendix 6. Cotton acreage without climate change (1000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	159.4	194.4	235.2	283.5	269.0	296.0	159.0	186.5	221.3	159.4	194.4	235.2	283.5	269.0	296.0	159.0	186.5	221.3
Burkina Faso	19.4	23.6	27.0	29.6	27.9	33.3	40.0	48.3	58.5	19.4	23.6	15.1	13.5	7.1	7.0	7.1	7.6	8.3
Cote d'Ivoire	353.6	431.0	395.0	237.0	258.3	289.8	295.6	294.2	295.5	353.6	431.0	395.0	237.0	258.3	289.8	295.6	294.2	295.5
Gambia	1.9	2.4	2.9	3.5	4.3	5.2	6.3	7.7	9.4	1.9	2.4	2.9	3.5	4.3	5.2	6.3	7.7	9.4
Ghana	34.3	41.8	46.8	49.3	38.4	44.7	46.1	48.3	51.3	34.3	41.8	46.8	49.3	38.4	44.7	46.1	48.3	51.3
Guinea	43.7	53.3	54.9	48.0	55.2	54.3	53.5	53.0	52.5	43.7	53.3	54.9	48.0	55.2	54.3	53.5	53.0	52.5
Guinea Bissau	5.6	6.9	8.4	10.2	12.4	13.6	5.1	4.9	4.8	5.6	6.9	8.4	10.2	12.4	13.6	5.1	4.9	4.8
Mali	53.1	64.7	71.9	74.5	71.5	84.9	101.7	122.5	148.2	53.1	64.7	39.8	31.5	15.7	14.3	13.5	13.2	13.5
Niger	13.7	16.7	20.4	24.9	30.3	36.9	45.0	54.9	66.9	13.7	16.7	4.8	3.9	3.2	2.6	2.2	1.8	1.4
Nigeria	867.6	1057.6	907.0	389.2	296.4	277.4	252.5	251.8	260.5	867.6	1057.6	870.7	340.3	233.2	197.3	152.4	127.7	107.5
Senegal	59.8	72.9	88.9	108.3	130.4	158.9	189.7	222.0	198.2	59.8	46.4	33.9	34.5	34.8	37.8	38.3	38.3	39.0
Togo	161.6	197.0	236.3	280.8	275.3	327.8	326.6	339.2	355.1	161.6	197.0	236.3	280.8	275.3	327.8	326.6	339.2	355.1
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself							
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	159.4	194.4	235.2	283.5	269.0	296.0	159.0	186.5	221.3	159.4	194.4	235.2	283.5	269.0	296.0	159.0	186.5	221.3
Burkina Faso	19.4	23.6	27.0	29.6	27.9	33.3	40.0	48.3	58.5	19.4	23.6	27.0	29.6	27.9	33.3	40.0	48.3	58.5
Cote d'Ivoire	353.6	431.0	395.0	237.0	258.3	289.8	295.6	294.2	295.5	353.6	431.0	395.0	237.0	258.3	289.8	295.6	294.2	295.5
Gambia	1.9	2.4	2.9	3.5	4.3	5.2	6.3	7.7	9.4	1.9	2.4	2.9	3.5	4.3	5.2	6.3	7.7	9.4
Ghana	34.3	41.8	46.8	49.3	38.4	44.7	46.1	48.3	51.3	34.3	41.8	46.8	49.3	38.4	44.7	46.1	48.3	51.3
Guinea	43.7	53.3	54.9	48.0	55.2	54.3	53.5	53.0	52.5	43.7	53.3	54.9	48.0	55.2	54.3	53.5	53.0	52.5
Guinea Bissau	5.6	6.9	8.4	10.2	12.4	13.6	5.1	4.9	4.8	5.6	6.9	8.4	10.2	12.4	13.6	5.1	4.9	4.8
Mali	53.1	64.7	71.9	74.5	71.5	84.9	101.7	122.5	148.2	53.1	64.7	71.9	74.5	71.5	84.9	101.7	122.5	148.2
Niger	13.7	16.7	20.4	24.9	30.3	36.9	45.0	54.9	66.9	13.7	16.7	20.4	24.9	30.3	36.9	45.0	54.9	66.9
Nigeria	867.6	1057.6	907.0	389.2	296.4	277.4	252.5	251.8	260.5	867.6	1057.6	907.0	389.2	296.4	277.4	252.5	251.8	260.5
Senegal	59.8	72.9	88.9	108.3	130.4	158.9	189.7	222.0	198.2	59.8	72.9	88.9	108.3	130.4	158.9	189.7	222.0	198.2
Togo	161.6	197.0	236.3	280.8	275.3	327.8	326.6	339.2	355.1	161.6	197.0	236.3	280.8	275.3	327.8	326.6	339.2	355.1

Appendix 7. Cocoa, coffee, and sesame acreage without climate change (1,000,000 ha)

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cote d'Ivoire	1.5	1.8	1.9	2.0	2.0	2.0	2.1	2.2	2.2	1.5	1.8	1.9	2.0	2.0	2.0	2.1	2.2	2.2	
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ghana	1.2	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.2	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
Guinea	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Nigeria	1.7	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	1.7	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sierra Leone	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	
Togo	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cote d'Ivoire	1.5	1.8	1.9	2.0	2.0	2.0	2.1	2.2	2.2	1.5	1.8	1.9	2.0	2.0	2.0	2.1	2.2	2.2	
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ghana	1.2	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.2	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
Guinea	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Nigeria	1.7	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	1.7	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sierra Leone	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	
Togo	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	

Appendix 8. Paddy rice production without climate change (100,000 tons)

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.6	0.7	0.9	1.1	1.4	1.9	2.7	3.7	5.1	0.6	0.7	0.9	1.1	1.4	1.9	2.7	3.7	5.1
Burkina Faso	1.1	1.4	1.9	2.5	3.4	4.8	6.7	9.5	13.2	1.1	1.4	1.9	2.5	3.4	4.8	6.7	9.5	13.2
Cote d'Ivoire	7.8	9.8	12.9	16.1	21.7	29.8	40.8	53.2	65.1	7.8	9.8	12.9	16.1	21.7	29.8	40.8	53.2	65.1
Gambia	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.0	1.2	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.0	1.2
Ghana	2.5	3.2	4.2	5.2	7.1	9.8	13.0	15.6	17.4	2.5	3.2	4.2	5.2	7.1	9.8	13.0	15.6	17.4
Guinea	14.7	18.6	24.5	32.9	45.0	60.5	75.9	86.1	96.5	14.7	18.6	24.5	32.9	45.0	60.5	75.9	86.1	96.5
Guinea Bissau	1.4	1.8	2.4	3.2	4.2	5.3	6.5	7.7	8.9	1.4	1.8	2.4	3.2	4.2	5.3	6.5	7.7	8.9
Liberia	0.9	1.1	1.4	2.0	2.7	3.8	4.7	5.1	5.3	0.9	1.1	1.4	2.0	2.7	3.8	4.7	5.1	5.3
Mali	2.2	2.8	3.6	4.9	6.9	9.7	13.6	19.2	26.7	2.2	2.8	3.6	4.9	6.9	9.7	13.6	19.2	26.7
Niger	0.5	0.7	0.9	1.2	1.7	2.4	3.3	4.7	6.6	0.5	0.7	0.9	1.2	1.7	2.4	3.3	4.7	6.6
Nigeria	49.1	61.4	79.5	100.3	133.7	177.7	224.9	278.6	331.7	49.1	61.4	79.5	100.3	133.7	177.7	224.9	278.6	331.7
Senegal	2.4	3.0	4.0	5.4	7.5	10.5	14.9	20.4	27.7	2.4	3.0	4.0	5.4	7.5	10.5	14.9	20.4	27.7
Sierra Leone	7.5	9.5	12.5	17.1	23.9	31.8	35.6	36.6	35.4	7.5	9.5	12.5	17.1	23.9	31.8	35.6	36.6	35.4
Togo	0.7	0.9	1.2	1.6	2.1	3.0	4.1	5.5	7.2	0.7	0.9	1.2	1.6	2.1	3.0	4.1	5.5	7.2
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.6	0.7	0.9	1.1	1.4	1.9	2.7	3.7	5.1	0.6	0.7	0.9	1.1	1.4	1.9	2.7	3.7	5.1
Burkina Faso	1.1	1.4	1.9	2.5	3.4	4.8	6.7	9.5	13.2	1.1	1.4	1.9	2.5	3.4	4.8	6.7	9.5	13.2
Cote d'Ivoire	7.8	9.8	12.9	16.1	21.7	29.8	40.8	53.2	65.1	7.8	9.8	12.9	16.1	21.7	29.8	40.8	53.2	65.1
Gambia	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.0	1.2	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.0	1.2
Ghana	2.5	3.2	4.2	5.2	7.1	9.8	13.0	15.6	17.4	2.5	3.2	4.2	5.2	7.1	9.8	13.0	15.6	17.4
Guinea	14.7	18.6	24.5	32.9	45.0	60.5	75.9	86.1	96.5	14.7	18.6	24.5	32.9	45.0	60.5	75.9	86.1	96.5
Guinea Bissau	1.4	1.8	2.4	3.2	4.2	5.3	6.5	7.7	8.9	1.4	1.8	2.4	3.2	4.2	5.3	6.5	7.7	8.9
Liberia	0.9	1.1	1.4	2.0	2.7	3.8	4.7	5.1	5.3	0.9	1.1	1.4	2.0	2.7	3.8	4.7	5.1	5.3
Mali	2.2	2.8	3.6	4.9	6.9	9.7	13.6	19.2	26.7	2.2	2.8	3.6	4.9	6.9	9.7	13.6	19.2	26.7
Niger	0.5	0.7	0.9	1.2	1.7	2.4	3.3	4.7	6.6	0.5	0.7	0.9	1.2	1.7	2.4	3.3	4.7	6.6
Nigeria	49.1	61.4	79.5	100.3	133.7	177.7	224.9	278.6	331.7	49.1	61.4	79.5	100.3	133.7	177.7	224.9	278.6	331.7
Senegal	2.4	3.0	4.0	5.4	7.5	10.5	14.9	20.4	27.7	2.4	3.0	4.0	5.4	7.5	10.5	14.9	20.4	27.7
Sierra Leone	7.5	9.5	12.5	17.1	23.9	31.8	35.6	36.6	35.4	7.5	9.5	12.5	17.1	23.9	31.8	35.6	36.6	35.4
Togo	0.7	0.9	1.2	1.6	2.1	3.0	4.1	5.5	7.2	0.7	0.9	1.2	1.6	2.1	3.0	4.1	5.5	7.2

Appendix 9. Cereals production without climate change (100,000 tons)

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	14.9	18.2	22.7	28.7	36.4	44.7	55.8	70.3	88.7	14.8	18.2	22.7	28.7	36.4	44.7	55.8	63.6	75.3
Burkina Faso	42.6	54.5	71.0	93.7	118.1	145.5	180.5	224.7	281.4	37.4	52.9	68.6	90.2	113.0	138.5	172.3	175.0	85.8
Cote d'Ivoire	7.1	8.7	8.6	8.8	7.1	6.8	6.3	6.6	7.5	7.1	8.7	8.6	8.8	7.1	6.8	6.3	6.6	7.5
Gambia	2.5	3.1	4.0	5.4	6.9	8.5	10.7	13.6	17.3	2.2	3.1	4.0	5.4	6.9	8.5	10.7	10.6	4.4
Ghana	13.4	16.4	19.7	22.9	26.5	28.7	31.0	34.2	38.2	13.4	16.4	19.7	22.9	26.5	28.7	31.0	34.0	36.7
Guinea	1.5	1.9	2.4	3.1	3.7	4.3	5.7	7.8	10.6	1.5	1.9	2.4	3.1	3.7	4.3	5.7	7.8	10.6
Guinea Bissau	1.1	1.4	1.6	1.9	2.2	2.5	2.8	3.2	3.8	1.1	1.4	1.6	1.9	2.2	2.5	2.8	3.2	3.8
Liberia	0.1	0.2	0.2	0.3	0.4	0.3	0.5	0.7	0.9	0.1	0.2	0.2	0.3	0.4	0.3	0.5	0.7	0.9
Mali	37.2	50.1	64.3	82.6	103.3	125.4	152.7	186.0	227.8	33.4	44.4	56.3	71.6	87.9	106.4	130.8	134.7	77.1
Niger	69.3	100.4	102.2	104.7	107.0	109.5	128.2	152.0	181.4	66.9	67.9	70.8	76.5	86.3	99.8	117.6	62.0	44.0
Nigeria	199.7	241.7	289.3	345.9	403.0	453.9	520.5	600.5	694.2	192.1	235.2	279.9	332.6	384.2	432.0	495.7	531.5	389.9
Senegal	10.9	15.0	19.5	25.5	34.0	40.8	51.2	65.2	83.6	8.8	12.0	14.7	18.4	23.6	30.3	39.7	41.2	20.5
Sierra Leone	1.2	1.5	2.0	2.7	3.7	1.2	1.2	1.4	1.8	1.2	1.5	2.0	2.7	3.7	1.2	1.2	1.4	1.8
Togo	5.4	6.8	8.9	11.4	14.1	16.6	19.6	23.3	27.6	5.4	6.8	8.9	11.4	14.1	16.6	19.6	23.3	27.6
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	14.8	18.2	22.7	28.7	36.4	44.7	55.8	70.3	88.7	14.9	18.2	22.7	28.7	36.4	44.7	55.8	70.3	88.7
Burkina Faso	37.5	54.5	71.0	93.7	118.1	145.5	180.5	224.7	281.4	43.5	54.5	71.0	93.7	118.1	145.5	180.5	224.7	281.4
Cote d'Ivoire	7.1	8.7	8.6	8.8	7.1	6.8	6.3	6.6	7.5	7.1	8.7	8.6	8.8	7.1	6.8	6.3	6.6	7.5
Gambia	2.2	3.1	4.0	5.4	6.9	8.5	10.7	13.6	17.3	2.5	3.1	4.0	5.4	6.9	8.5	10.7	13.6	17.3
Ghana	13.4	16.4	19.7	22.9	26.5	28.7	31.0	34.2	38.2	13.4	16.4	19.7	22.9	26.5	28.7	31.0	34.2	38.2
Guinea	1.5	1.9	2.4	3.1	3.7	4.3	5.7	7.8	10.6	1.5	1.9	2.4	3.1	3.7	4.3	5.7	7.8	10.6
Guinea Bissau	1.1	1.4	1.6	1.9	2.2	2.5	2.8	3.2	3.8	1.1	1.4	1.6	1.9	2.2	2.5	2.8	3.2	3.8
Liberia	0.1	0.2	0.2	0.3	0.4	0.3	0.5	0.7	0.9	0.1	0.2	0.2	0.3	0.4	0.3	0.5	0.7	0.9
Mali	33.6	50.1	64.3	82.6	103.3	125.4	152.7	186.0	227.8	40.3	50.1	64.3	82.6	103.3	125.4	152.7	186.0	227.8
Niger	67.2	100.4	102.2	104.7	107.0	109.5	128.2	152.0	181.4	91.5	100.4	102.2	104.7	107.0	109.5	128.2	152.0	181.4
Nigeria	193.2	241.7	289.3	345.9	403.0	453.9	520.5	600.5	694.2	203.0	241.7	289.3	345.9	403.0	453.9	520.5	600.5	694.2
Senegal	8.9	15.0	19.5	25.5	34.0	40.8	51.2	65.2	83.6	12.1	15.0	19.5	25.5	34.0	40.8	51.2	65.2	83.6
Sierra Leone	1.2	1.5	2.0	2.7	3.7	1.2	1.2	1.4	1.8	1.2	1.5	2.0	2.7	3.7	1.2	1.2	1.4	1.8
Togo	5.4	6.8	8.9	11.4	14.1	16.6	19.6	23.3	27.6	5.4	6.8	8.9	11.4	14.1	16.6	19.6	23.3	27.6

Appendix 10. Vegetable, and fruits production without climate change (1,000,000 tons)

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	5.5	7.0	9.1	11.1	13.7	17.1	21.6	27.7	35.5	5.5	7.0	9.1	11.1	13.7	17.1	21.6	27.7	35.5	
Burkina Faso	0.3	0.3	0.4	0.6	0.7	0.9	1.0	1.3	1.5	0.3	0.3	0.4	0.6	0.7	0.9	1.0	1.3	1.5	
Cote d'Ivoire	14.2	18.0	23.8	32.4	42.6	56.8	73.5	88.9	107.7	14.2	18.0	23.8	32.4	42.6	56.8	73.5	88.9	107.7	
Gambia	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	
Ghana	15.7	19.9	26.2	35.5	48.3	66.5	88.6	105.6	125.7	15.7	19.9	26.2	35.5	48.3	66.5	88.6	105.6	125.7	
Guinea	3.6	4.6	5.5	6.9	8.9	11.8	15.7	21.1	28.4	3.6	4.6	5.5	6.9	8.9	11.8	15.7	21.1	28.4	
Guinea Bissau	0.2	0.2	0.3	0.4	0.6	0.8	1.2	1.6	2.2	0.2	0.2	0.3	0.4	0.6	0.8	1.2	1.6	2.2	
Liberia	1.0	1.3	1.7	2.4	3.3	4.6	6.5	9.2	12.9	1.0	1.3	1.7	2.4	3.3	4.6	6.5	9.2	12.9	
Mali	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.9	1.2	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.9	1.2	
Niger	0.2	0.2	0.3	0.4	0.6	0.9	1.2	1.8	2.5	0.2	0.2	0.3	0.4	0.6	0.9	1.2	1.8	2.5	
Nigeria	97.3	116.0	140.9	175.2	216.5	272.2	339.5	416.3	511.8	97.3	116.0	140.9	175.2	216.5	272.2	339.5	416.3	511.8	
Senegal	0.9	1.0	1.2	1.4	1.7	2.0	2.5	3.1	3.8	0.9	1.0	1.2	1.4	1.7	2.0	2.5	3.0	3.8	
Sierra Leone	3.1	3.9	5.2	7.1	9.9	13.9	19.7	27.7	38.9	3.1	3.9	5.2	7.1	9.9	13.9	19.7	27.7	38.9	
Togo	2.2	2.8	3.6	4.3	5.3	6.6	8.3	10.5	13.4	2.2	2.8	3.6	4.3	5.3	6.6	8.3	10.5	13.4	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	5.5	7.0	9.1	11.1	13.7	17.1	21.6	27.7	35.5	5.5	7.0	9.1	11.1	13.7	17.1	21.6	27.7	35.5	
Burkina Faso	0.3	0.3	0.4	0.6	0.7	0.9	1.0	1.3	1.5	0.3	0.3	0.4	0.6	0.7	0.9	1.0	1.3	1.5	
Cote d'Ivoire	14.2	18.0	23.8	32.4	42.6	56.8	73.5	88.9	107.7	14.2	18.0	23.8	32.4	42.6	56.8	73.5	88.9	107.7	
Gambia	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	
Ghana	15.7	19.9	26.2	35.5	48.3	66.5	88.6	105.6	125.7	15.7	19.9	26.2	35.5	48.3	66.5	88.6	105.6	125.7	
Guinea	3.6	4.6	5.5	6.9	8.9	11.8	15.7	21.1	28.4	3.6	4.6	5.5	6.9	8.9	11.8	15.7	21.1	28.4	
Guinea Bissau	0.2	0.2	0.3	0.4	0.6	0.8	1.2	1.6	2.2	0.2	0.2	0.3	0.4	0.6	0.8	1.2	1.6	2.2	
Liberia	1.0	1.3	1.7	2.4	3.3	4.6	6.5	9.2	12.9	1.0	1.3	1.7	2.4	3.3	4.6	6.5	9.2	12.9	
Mali	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.9	1.2	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.9	1.2	
Niger	0.2	0.2	0.3	0.4	0.6	0.9	1.2	1.8	2.5	0.2	0.2	0.3	0.4	0.6	0.9	1.2	1.8	2.5	
Nigeria	97.3	116.0	140.9	175.2	216.5	272.2	339.5	416.3	511.8	97.3	116.0	140.9	175.2	216.5	272.2	339.5	416.3	511.8	
Senegal	0.9	1.0	1.2	1.4	1.7	2.0	2.5	3.1	3.8	0.9	1.0	1.2	1.4	1.7	2.0	2.5	3.1	3.8	
Sierra Leone	3.1	3.9	5.2	7.1	9.9	13.9	19.7	27.7	38.9	3.1	3.9	5.2	7.1	9.9	13.9	19.7	27.7	38.9	
Togo	2.2	2.8	3.6	4.3	5.3	6.6	8.3	10.5	13.4	2.2	2.8	3.6	4.3	5.3	6.6	8.3	10.5	13.4	

Appendix 11. Oil seeds production without climate change (100,000 tons)

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	5.0	6.4	8.4	11.4	15.9	22.2	27.2	30.3	29.5	5.0	6.4	8.4	11.4	15.9	22.2	27.2	30.1	29.2
Burkina Faso	3.6	4.5	6.0	8.0	10.9	14.9	20.2	27.2	33.2	3.6	4.5	5.5	7.3	9.6	13.4	19.7	22.8	27.9
Cote d'Ivoire	5.6	7.0	8.5	9.9	11.4	11.1	9.9	7.2	4.2	5.6	7.0	8.5	9.9	11.4	11.1	9.9	7.2	4.2
Gambia	0.5	0.6	0.7	0.8	1.0	1.2	1.5	2.0	2.3	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.9	2.3
Ghana	5.1	6.4	7.7	7.9	7.9	8.4	8.7	8.7	7.6	5.1	6.4	7.7	7.9	7.9	8.4	8.7	8.7	7.6
Guinea	2.1	2.7	3.4	3.9	4.1	4.2	4.2	3.9	3.2	2.1	2.7	3.4	3.9	4.1	4.2	4.2	3.9	3.2
Guinea Bissau	1.7	2.1	2.5	3.0	3.4	4.2	4.7	5.2	5.5	1.7	2.1	2.5	3.0	3.4	4.2	4.7	5.2	5.5
Liberia	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Mali	5.6	7.1	9.3	12.4	16.4	21.6	25.6	29.8	34.3	5.6	7.1	6.1	7.4	6.7	11.2	22.4	7.3	6.0
Niger	31.7	40.2	53.2	72.2	99.0	131.1	155.4	181.8	211.1	31.7	40.2	48.3	62.8	36.3	115.1	150.5	93.7	64.6
Nigeria	75.4	86.4	99.6	116.6	131.7	149.2	169.1	193.7	216.0	75.4	86.4	93.6	107.6	116.3	129.9	163.2	126.6	135.8
Senegal	5.9	7.4	9.8	13.1	17.6	24.0	28.6	33.1	38.0	5.9	7.4	4.0	4.4	4.7	5.3	22.8	2.3	2.2
Sierra Leone	1.3	1.6	2.1	2.7	1.5	1.4	1.5	1.6	1.7	1.3	1.6	2.1	2.7	1.5	1.4	1.5	1.6	1.7
Togo	2.6	3.3	4.1	5.2	6.7	7.9	8.9	9.4	9.6	2.6	3.3	4.1	5.2	6.7	7.9	8.9	9.4	9.6
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	5.0	6.4	8.4	11.4	15.9	22.2	27.2	30.3	29.5	5.0	6.4	8.4	11.4	15.9	22.2	27.2	30.3	29.5
Burkina Faso	3.6	4.5	6.0	8.0	10.9	14.9	20.2	27.2	33.2	3.6	4.5	6.0	8.0	10.9	14.9	20.2	27.2	33.2
Cote d'Ivoire	5.6	7.0	8.5	9.9	11.4	11.1	9.9	7.2	4.2	5.6	7.0	8.5	9.9	11.4	11.1	9.9	7.2	4.2
Gambia	0.5	0.6	0.7	0.8	1.0	1.2	1.5	2.0	2.3	0.5	0.6	0.7	0.8	1.0	1.2	1.5	2.0	2.3
Ghana	5.1	6.4	7.7	7.9	7.9	8.4	8.7	8.7	7.6	5.1	6.4	7.7	7.9	7.9	8.4	8.7	8.7	7.6
Guinea	2.1	2.7	3.4	3.9	4.1	4.2	4.2	3.9	3.2	2.1	2.7	3.4	3.9	4.1	4.2	4.2	3.9	3.2
Guinea Bissau	1.7	2.1	2.5	3.0	3.4	4.2	4.7	5.2	5.5	1.7	2.1	2.5	3.0	3.4	4.2	4.7	5.2	5.5
Liberia	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Mali	5.6	7.1	9.3	12.4	16.4	21.6	25.6	29.8	34.3	5.6	7.1	9.3	12.4	16.4	21.6	25.6	29.8	34.3
Niger	31.7	40.2	53.2	72.2	99.0	131.1	155.4	181.8	211.1	31.7	40.2	53.2	72.2	99.0	131.1	155.4	181.8	211.1
Nigeria	75.4	86.4	99.6	116.6	131.7	149.2	169.1	193.7	216.0	75.4	86.4	99.6	116.6	131.7	149.2	169.1	193.7	216.0
Senegal	5.9	7.4	9.8	13.1	17.6	24.0	28.6	33.1	38.0	5.9	7.4	9.8	13.1	17.6	24.0	28.6	33.1	38.0
Sierra Leone	1.3	1.6	2.1	2.7	1.5	1.4	1.5	1.6	1.7	1.3	1.6	2.1	2.7	1.5	1.4	1.5	1.6	1.7
Togo	2.6	3.3	4.1	5.2	6.7	7.9	8.9	9.4	9.6	2.6	3.3	4.1	5.2	6.7	7.9	8.9	9.4	9.6

Appendix 12. Sugarcane production without climate change (100,000 tons)

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	1.1	1.4	1.9	2.5	3.5	5.0	7.0	9.9	14.0	1.1	1.4	1.9	2.5	3.5	5.0	7.0	9.9	14.0
Burkina Faso	2.4	3.0	4.0	5.4	7.6	10.7	14.2	18.4	23.8	2.4	3.0	4.0	5.4	7.6	10.7	14.2	18.4	23.8
Cote d'Ivoire	13.2	16.7	22.1	30.2	40.3	51.3	66.2	86.2	112.6	13.2	16.7	22.1	30.2	40.3	51.3	66.2	86.2	112.6
Ghana	3.0	3.8	5.0	6.8	9.2	12.1	15.2	18.2	21.7	3.0	3.8	5.0	6.8	9.2	12.1	15.2	18.2	21.7
Guinea	3.4	4.3	5.7	7.8	10.8	15.2	21.4	30.3	42.4	3.4	4.3	5.7	7.8	10.8	15.2	21.4	30.3	42.4
Guinea Bissau	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.6	0.8	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.6	0.8
Liberia	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.9	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.9
Mali	3.9	4.9	6.5	8.8	12.2	17.2	24.3	34.3	48.2	3.9	4.9	6.5	8.8	12.2	17.2	24.3	34.3	48.2
Niger	3.2	4.0	5.3	7.2	10.0	14.1	19.9	28.0	39.4	3.2	4.0	5.3	7.2	10.0	14.1	19.9	28.0	39.4
Nigeria	13.8	13.4	15.2	18.4	23.5	31.0	41.9	57.3	78.8	13.8	13.4	15.2	18.4	23.5	31.0	41.9	57.3	78.8
Senegal	8.3	10.5	13.8	18.8	26.2	36.8	51.8	72.3	100.6	8.3	10.5	13.8	18.8	26.2	36.8	50.1	69.9	49.5
Sierra Leone	0.5	0.6	0.8	1.1	1.5	2.0	2.9	4.1	5.7	0.5	0.6	0.8	1.1	1.5	2.0	2.9	4.1	5.7
Togo	0.5	0.7	0.9	1.2	1.7	2.4	3.4	4.8	6.8	0.5	0.7	0.9	1.2	1.7	2.4	3.4	4.8	6.8
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	1.1	1.4	1.9	2.5	3.5	5.0	7.0	9.9	14.0	1.1	1.4	1.9	2.5	3.5	5.0	7.0	9.9	14.0
Burkina Faso	2.4	3.0	4.0	5.4	7.6	10.7	14.2	18.4	23.8	2.4	3.0	4.0	5.4	7.6	10.7	14.2	18.4	23.8
Cote d'Ivoire	13.2	16.7	22.1	30.2	40.3	51.3	66.2	86.2	112.6	13.2	16.7	22.1	30.2	40.3	51.3	66.2	86.2	112.6
Ghana	3.0	3.8	5.0	6.8	9.2	12.1	15.2	18.2	21.7	3.0	3.8	5.0	6.8	9.2	12.1	15.2	18.2	21.7
Guinea	3.4	4.3	5.7	7.8	10.8	15.2	21.4	30.3	42.4	3.4	4.3	5.7	7.8	10.8	15.2	21.4	30.3	42.4
Guinea Bissau	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.6	0.8	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.6	0.8
Liberia	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.9	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.9
Mali	3.9	4.9	6.5	8.8	12.2	17.2	24.3	34.3	48.2	3.9	4.9	6.5	8.8	12.2	17.2	24.3	34.3	48.2
Niger	3.2	4.0	5.3	7.2	10.0	14.1	19.9	28.0	39.4	3.2	4.0	5.3	7.2	10.0	14.1	19.9	28.0	39.4
Nigeria	13.8	13.4	15.2	18.4	23.5	31.0	41.9	57.3	78.8	13.8	13.4	15.2	18.4	23.5	31.0	41.9	57.3	78.8
Senegal	8.3	10.5	13.8	18.8	26.2	36.8	51.8	72.3	100.6	8.3	10.5	13.8	18.8	26.2	36.8	51.8	72.3	100.6
Sierra Leone	0.5	0.6	0.8	1.1	1.5	2.0	2.9	4.1	5.7	0.5	0.6	0.8	1.1	1.5	2.0	2.9	4.1	5.7
Togo	0.5	0.7	0.9	1.2	1.7	2.4	3.4	4.8	6.8	0.5	0.7	0.9	1.2	1.7	2.4	3.4	4.8	6.8

Appendix 13. Cotton production without climate change (10,000 tons)

	SSP1: Cash, Control & Calories										SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	14.0	17.7	23.2	31.2	33.4	42.5	27.0	36.8	50.3	14.0	17.7	23.2	31.2	33.4	42.5	27.0	36.8	50.3	
Burkina Faso	1.9	2.4	2.9	3.6	4.0	5.5	7.7	10.7	14.9	1.9	2.4	1.6	1.6	1.0	1.1	1.3	1.5	1.9	
Cote d'Ivoire	31.1	39.4	39.0	25.9	32.2	41.7	49.3	56.8	65.8	31.1	39.4	39.0	25.9	32.2	41.7	49.3	56.8	65.8	
Gambia	0.2	0.2	0.3	0.4	0.5	0.8	1.1	1.5	2.1	0.2	0.2	0.3	0.4	0.5	0.8	1.1	1.5	2.1	
Ghana	3.0	3.8	4.7	5.5	4.8	6.4	7.7	9.4	11.5	3.0	3.8	4.7	5.5	4.8	6.4	7.7	9.4	11.5	
Guinea	4.4	5.6	6.4	6.6	8.7	9.9	11.4	13.1	15.0	4.4	5.6	6.4	6.6	8.7	9.9	11.4	13.1	15.0	
Guinea Bissau	0.5	0.6	0.8	1.1	1.5	1.9	0.8	0.9	1.1	0.5	0.6	0.8	1.1	1.5	1.9	0.8	0.9	1.1	
Mali	5.1	6.4	7.8	9.2	10.2	14.1	19.6	27.4	38.0	5.1	6.4	4.2	3.7	2.1	2.2	2.4	2.7	3.2	
Niger	1.4	1.8	2.3	3.2	4.4	6.2	8.8	12.4	17.3	1.4	1.8	0.6	0.5	0.5	0.4	0.4	0.4	0.4	
Nigeria	77.5	98.3	91.6	44.9	39.6	43.3	46.5	54.3	65.3	77.5	98.3	87.4	38.7	30.4	29.9	27.0	26.4	25.7	
Senegal	5.0	6.4	8.4	11.5	15.8	22.2	30.7	41.7	43.9	5.0	4.3	3.3	3.7	4.3	5.4	6.3	7.4	8.6	
Togo	14.1	17.9	23.2	30.9	34.2	47.0	54.4	65.5	79.1	14.1	17.9	23.2	30.9	34.2	47.0	54.4	65.5	79.1	
	SSP3: Civil Society to the Rescue?										SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100	
Benin	14.0	17.7	23.2	31.2	33.4	42.5	27.0	36.8	50.3	14.0	17.7	23.2	31.2	33.4	42.5	27.0	36.8	50.3	
Burkina Faso	1.9	2.4	2.9	3.6	4.0	5.5	7.7	10.7	14.9	1.9	2.4	2.9	3.6	4.0	5.5	7.7	10.7	14.9	
Cote d'Ivoire	31.1	39.4	39.0	25.9	32.2	41.7	49.3	56.8	65.8	31.1	39.4	39.0	25.9	32.2	41.7	49.3	56.8	65.8	
Gambia	0.2	0.2	0.3	0.4	0.5	0.8	1.1	1.5	2.1	0.2	0.2	0.3	0.4	0.5	0.8	1.1	1.5	2.1	
Ghana	3.0	3.8	4.7	5.5	4.8	6.4	7.7	9.4	11.5	3.0	3.8	4.7	5.5	4.8	6.4	7.7	9.4	11.5	
Guinea	4.4	5.6	6.4	6.6	8.7	9.9	11.4	13.1	15.0	4.4	5.6	6.4	6.6	8.7	9.9	11.4	13.1	15.0	
Guinea Bissau	0.5	0.6	0.8	1.1	1.5	1.9	0.8	0.9	1.1	0.5	0.6	0.8	1.1	1.5	1.9	0.8	0.9	1.1	
Mali	5.1	6.4	7.8	9.2	10.2	14.1	19.6	27.4	38.0	5.1	6.4	7.8	9.2	10.2	14.1	19.6	27.4	38.0	
Niger	1.4	1.8	2.3	3.2	4.4	6.2	8.8	12.4	17.3	1.4	1.8	2.3	3.2	4.4	6.2	8.8	12.4	17.3	
Nigeria	77.5	98.3	91.6	44.9	39.6	43.3	46.5	54.3	65.3	77.5	98.3	91.6	44.9	39.6	43.3	46.5	54.3	65.3	
Senegal	5.0	6.4	8.4	11.5	15.8	22.2	30.7	41.7	43.9	5.0	6.4	8.4	11.5	15.8	22.2	30.7	41.7	43.9	
Togo	14.1	17.9	23.2	30.9	34.2	47.0	54.4	65.5	79.1	14.1	17.9	23.2	30.9	34.2	47.0	54.4	65.5	79.1	

Appendix 14. Cocoa, coffee, and sesame production without climate change (10,000 tons)

	SSP1: Cash, Control & Calories									SSP2: Self-determination								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.9	1.2	1.6	2.1	3.0	4.2	5.9	8.3	11.7	0.9	1.2	1.6	2.1	3.0	4.2	5.9	8.3	11.7
Burkina Faso	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.4	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.4
Cote d'Ivoire	69.5	88.3	104.7	118.8	137.4	161.6	191.4	227.3	266.4	69.5	88.3	104.7	118.8	137.4	161.6	191.4	227.3	266.4
Gambia	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5
Ghana	55.4	70.3	83.0	93.5	107.2	124.6	144.1	166.1	190.5	55.4	70.3	83.0	93.5	107.2	124.6	144.1	166.1	190.5
Guinea	4.2	5.3	6.7	8.4	10.8	14.2	18.9	25.3	31.8	4.2	5.3	6.7	8.4	10.8	14.2	18.9	25.3	31.8
Liberia	0.6	0.7	1.0	1.3	1.8	2.6	3.4	4.4	4.1	0.6	0.7	1.0	1.3	1.8	2.6	3.4	4.4	4.1
Mali	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.5
Nigeria	80.6	102.3	120.3	134.5	152.9	175.9	202.9	233.7	267.7	80.6	102.3	120.3	134.5	152.9	175.9	202.9	233.7	267.7
Senegal	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6
Sierra Leone	2.7	3.4	4.6	6.2	8.6	12.2	16.5	22.1	18.5	2.7	3.4	4.6	6.2	8.6	12.2	16.5	22.1	18.5
Togo	4.6	5.8	7.4	9.3	12.2	16.2	21.7	29.4	39.8	4.6	5.8	7.4	9.3	12.2	16.2	21.7	29.4	39.8
	SSP3: Civil Society to the Rescue?									SSP4: Save Yourself								
	2020	2030	2040	2050	2060	2070	2080	2090	2100	2020	2030	2040	2050	2060	2070	2080	2090	2100
Benin	0.9	1.2	1.6	2.1	3.0	4.2	5.9	8.3	11.7	0.9	1.2	1.6	2.1	3.0	4.2	5.9	8.3	11.7
Burkina Faso	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.4	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.4
Cote d'Ivoire	69.5	88.3	104.7	118.8	137.4	161.6	191.4	227.3	266.4	69.5	88.3	104.7	118.8	137.4	161.6	191.4	227.3	266.4
Gambia	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5
Ghana	55.4	70.3	83.0	93.5	107.2	124.6	144.1	166.1	190.5	55.4	70.3	83.0	93.5	107.2	124.6	144.1	166.1	190.5
Guinea	4.2	5.3	6.7	8.4	10.8	14.2	18.9	25.3	31.8	4.2	5.3	6.7	8.4	10.8	14.2	18.9	25.3	31.8
Liberia	0.6	0.7	1.0	1.3	1.8	2.6	3.4	4.4	4.1	0.6	0.7	1.0	1.3	1.8	2.6	3.4	4.4	4.1
Mali	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.5
Nigeria	80.6	102.3	120.3	134.5	152.9	175.9	202.9	233.7	267.7	80.6	102.3	120.3	134.5	152.9	175.9	202.9	233.7	267.7
Senegal	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6
Sierra Leone	2.7	3.4	4.6	6.2	8.6	12.2	16.5	22.1	18.5	2.7	3.4	4.6	6.2	8.6	12.2	16.5	22.1	18.5
Togo	4.6	5.8	7.4	9.3	12.2	16.2	21.7	29.4	39.8	4.6	5.8	7.4	9.3	12.2	16.2	21.7	29.4	39.8

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MATE MASIE

“What I hear, I
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wisdom, knowledge
and understanding.



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can know from learning,
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education and continued



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