FOCUS AREA
Improved mitigation strategies of plants in the context of climate change. Evidence from some food/fodder and cash crops (sorghum, cowpea, cocoa and Andropogon gayanus) in West Africa

CHALLENGES
Sorghum, cowpea and cocoa are crops grown for human consumption, animal feeding or energy production, and are also used as cash crops providing important income for farmers in West Africa. Andropogon gayanus is herbaceous species of savannah ecosystems in West Africa commonly used for livestock feeding. Moreover, the fodder species (Moringa oleifera, Leucaena leucocephala, Newbouldia laevis, etc.) is used as an alternative in livestock feeding and care as substitutes to conventional chemotherapeutic drugs.

All these crops/species are facing climate worsening effects resulting in limited water access for agricultural production. Drought stress affects the crop/species depending on the developmental stage, its severity, the duration of the stress and the species itself. Drought stress can dramatically affect yield and even causes a total failure of the crop. In sub-Saharan Africa (SSA), the effect of this stress becomes severe because of low soil fertility. Therefore, it is crucial to identify new strategies to reduce drought effects on these crops/species in order to achieve better production in West Africa.

FACTS AND FIGURES
Multipurpose sweet sorghum
In West Africa, drought is among the most severe constraints impairing sorghum cultivation. It is ranked by the farmers as the second most important constraint related to sorghum cultivation in Burkina Faso (Figure 1) (Ouedraogo et al., 2017). To combat drought, the farmers declared mostly using adequate and humid soil, technical practices (hand weeding, hoe weeding, hilling) and soil conservation and restoration practices. Few of them declared using early planting, early material and prayers (Figure 2).

In Senegal, in 2013 and 2014 we conducted field experiments testing twelve sorghum varieties with similar phenology, submitted two sowing dates (July & August) and two post flowering water treatments (irrigated, non irrigated) (Photo 1). Our results showed that late sowing date led to the reduction of sugar and grain...
production more than post-flowering drought, whereas early sowing enhanced both types of production (Photo 2). No post-flowering competition was found between grain filling and stem sugar accumulation. However, under drought conditions, the maintenance of combined production was better for the most leaf stay-green varieties.

**Cowpea cultivation in West Africa**

Based on the last 15 years’ FAO data, there were some fluctuations for both cowpea production and harvested areas in Mali with decreasing of number of hectares exploited and amount of grains produced from 2013 and 2014, respectively (Figure 3). Survey conducted within villages from two growing districts of cowpea, Ségou and Koutiala, revealed drought as a major constraint preventing farmers from getting acceptable yield from their cowpea field followed by diseases, insects, *Striga gesnerioides* and low fertility (Figure 4). The drought level emphasizes the insidance of these last factors. These two figures show the importance of improving cowpea adaptation to drought stress, as higher levels of drought incidence is becoming a more severe constraint to cowpea production in SSA due to climate change.

**Cocoa cultivation in West Africa**

Côte-d’Ivoire and Ghana are by far the two largest producers of cocoa in the world. Ghana is the second largest producer and its production accounts for 21% of the world’s cocoa beans and employs over 6 million Ghanaians (Figure 5). Climate change is predicted to cause a drastic decrease of climatic suitability for cocoa in current growing regions of Ghana (Photo 4). Cocoa farmers have resorted to different adaptation strategies to help cope with the impact of climate variabilities. Among these strategies,
the most used are adoption of improved varieties, creating of the fire belt around cocoa farms, mixed cropping cocoa with other crops, and planting shade trees or plants as protective cover (Figure 6).

**Development of Andropogon gayanus**

In Burkina Faso, the field data collection shows the decrease in the performance of the functional traits related to the fresh and dry weight, the canopy height and the diaspore release height in Sahelian dry conditions compared to the Soudanian dry conditions (Figure 7). However, the species is found to produce more seeds under dry conditions in the Sahelian zone than under wet conditions in the Sudanian zone (Photo 5).

**SOLUTION**

The mitigation strategies to climate change are varied and depend on the context and choice of each project:

**Multipurpose sweet sorghum**

Taking into account photoperiod-sensitivity by applying early-sowing date to produce important biomass before anthesis and the use of stay-green genotypes to allow the plant to keep performing photosynthesis and fill directly the panicle using the carbon assimilates from the photosynthesis instead of remobilizing the carbohydrates from the stem.

**Cowpea**

Development of new cowpea lines tolerant/resistant to drought with farmers’ preferred traits in addition to the use of Zai (A) and Half-moon (B) technics (Photo 6) for rainwater holding could increase cowpea production in SSA. Water-holding techniques associated with organic fertilizer application, such as compost, will maintain soil humidity for a long time. Growing new varieties of cowpea tolerant/resistant to drought with dual purpose - grain and fodder - will increase farmers’ income and reduce the cost of their livestock feeding.

**Cocoa**

Potassium (K) fertilizers application as biostimulant to enhance cocoa seedling resilience to drought. K is involved in activating a wide range of enzyme systems that regulate photosynthesis, water use efficiency and movement, nitrogen uptake, and protein-building in plants.

**Andropogon gayanus**

To combat drought, the species produces more seeds, which allows it to ensure its sustainability in drier conditions. Therefore, it provides perspectives on the cultivation pathways of *Andropogon gayanus* in the semi-arid areas as a high fodder species.

**Plant phytochemical constituents: alternative in livestock production.**

The delayed onset of rainy season and associated increased temperature may allow the emergence of new diseases through adaptation mechanism. In this case, most of the conventional drugs (anthelminthic and antibiotics) are constantly losing efficacy.

The use of the fodder species (*Moringa oleifera*, *Leucaena leucocephala*, *Newbouldia laevis*, etc.) in livestock...
feeding provides substitutes for conventional chemo-therapeutic drugs through their phytochemical constituents like flavonoids, saponin and tannin with anthelmintic, antioxidants and antidiarrheal etc.

HOW CAN THE CLIMAPAFRICA PROGRAM CONTRIBUTE TO ADDRESS THE CHALLENGE?

The ClimapAfrica program has created an opportunity for us to meet and interact with colleagues, alumni and stakeholders on climate change related topics. In addition, the training and capacity building programmes organized by the various DAAD ClimapAfrica working groups have been beneficial to us. This diverse expertise has been beneficial in enhancing our knowledge and creating the opportunities to improve our research approach, methods and parameters that we intend measuring as indicators of resilience to climate change. In addition, we have an opportunity to disseminate our research findings and share our opinion on the DAAD ClimapAfrica program website, which can be accessed by a wider scientific community made up of researchers, policy makers and stakeholders in the climate change sector.