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CLIMATE-SMART AGRICULTURE IN BENIN: NEED ASSESSMENT REPORT (PRACTICES, RELATED POLICIES AND INFUSION IN UNIVERSITIES' ACADEMIC PROGRAMS)

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Climate-Smart Agriculture In Benin: Need Assessment Report (practices, related policies and infusion in universities' academic programs)

Introduction

Agriculture in Africa must undergo a major transformation in the coming decades in order to meet the interrelated challenges of achieving food security, reducing poverty, and addressing climate change without depleting the natural resource base. Although agriculture is an important part of Africa's economy, employing more than 60% of the population and contributing between 25% and 34% of GDP, productivity is low and food insecurity is high. Currently, about 48% of Africa's population, or approximately 450 million people, live in extreme poverty on less than US$1.25 per day; 63% of the continent's poor live in rural areas and depend on agriculture for their livelihoods (World Bank, 2015). At the same time, the continent is experiencing rapid population growth and urbanization. Half of the projected 2.4 billion increase in the world's population between 2013 and 2050 will occur in sub-Saharan Africa (SSA), and 56 percent of Africa's population is expected to live in urban areas by 2025 (UNODAES, 2013 and 2014). Meeting future food demand will require a large increase in supply. With these challenges, agricultural practices on the African continent cannot continue as usual. African agriculture must therefore transform itself to improve food and nutrition security for an expanding population and to provide a basis for economic growth and poverty reduction.

Climate-smart agriculture (CSA), a concept developed by the FAO, is an approach to creating the technical, policy and financial conditions for achieving sustainable agricultural development that promotes food security in the context of climate change (FAO, 2014). It integrates the three dimensions of sustainable development (economic, social and environmental) by targeting the challenges of food security, ecosystem management and climate change at the same time. It consists of three main pillars: - Sustainable increase in agricultural productivity and income; - Adaptation and strengthening of resilience to climate change; - Reduction of greenhouse gas emissions and/or absorption where possible. CSA is not a single specific agricultural technology or practice that can be applied universally. It is an approach that requires site-specific assessments of social, economic, and environmental conditions to identify appropriate technologies and agricultural production practices. A key element of CSA is an integrated landscape approach that follows the principles of ecosystem management and sustainable land and water use.

Although there has been rapid acceptance of CSA by national organizations and the international community, implementation of the approach is still limited due to a lack of tools, capacity, and experience This technical report analyzes the practices, related policies and infusion in universities' academic programs.

1. Climate smart agriculture practices in nine African countries

During the meeting involving representatives from nine (9) African countries held in Cotonou, Benin at RUFORUM's Triennial conference on 12-13th Dec 2021, a review was initiated to provide a baseline information on preferred climate-smart agriculture (CSA) practices and existing programmes in institutions of higher learning in the represented countries that included Kenya, Zambia, Ethiopia, Democratic republic of Congo, Benin, Burundi, Uganda, Ghana and Zimbabwe. Table 1 shows clusters of preferred CSA practices ranked by the representatives of institutions of higher learning from the aforementioned countries.

TABLE 1: Clustered priority areas for the targeted African countries									
Clusters	**Zambia**	**Ethiopia**	**Kenya**	**DRC**	**Benin**	**Burundi**	**Uganda**	**Ghana**	**Zimbabwe**
1) LRA	1	1	1	1	1	1	2	3	1
2) CD		2	3		2	2	1	2	3
3) ISFM	4	3	4	3	4	3	4	1	
4) WHM	2		2			4			
5) LAM	3	4		2					2
6) PHM							3	4	
7) SBE				4					4
8) MVM					3				

Key: Ranking of **1** to **4,** where **1** indicates highest rank, while **4** indicates lowest rank in terms of priority

CSA Clusters:

1. Land Restoration and Agroforestry system-**LRA**
2. Crop Diversification-**CD**
3. Integrated Soil Fertility and Management-**ISFM**
4. Water Harvesting and Management-Small scale irrigation-**WHM**
5. Post-Harvest Handling-**PHM**
6. Sustainable Bio-Energy-**SBE**
7. Market, Value chain and Micro-finance-**MVM**
8. Livestock and Aquaculture Management-**LAM**

Based on their priority CSA clusters, each country was tasked with further review to:

i. Compile information about CSA practices and interventions; and
ii. Provide inventory of existing Universities' course units/academic programs related to CSA.

2. Climate Information System (CSI) needs in Benin

In a developing country such as Benin, climate change impacts are exacerbated by limited outreach mechanisms to local levels and a country dependence on subsistence agriculture. For Benin, improving Climate Information (CI) collection and developing an Early Warning System (EWS) is an effective way to build the general population's weather / climate risk awareness so that communities (particularly rain-fed farmers) can prepare accordingly. However, currently, an early warning system for multi-risk forecasting (e.g. coastal surge and flooding) as well as the capacities to produce and disseminate weather/climate information does not work properly in Benin.

The capacity of the hydrometeorological services and networks to monitor and predict climate variability and extreme weather events, namely floods, droughts, sea level rise and strong winds is poor in the country. Indeed, good weather forecasts and climate predictions should facilitate Benin to respond to extreme weather events and plan for long-term climate resilient development planning at the national and sectorial levels. In order to fill this gap the country need:

1. Enhanced capacity of national hydro-meteorological services and environmental institutions to monitor extreme weather and climate change Weather and climate monitoring. To that end equipments like rain gauges, Doppler flow meters and synoptic weather stations are needed. A mix of manual and automatic stations should be used to support a gradual transition to a fully automated information collection system.

2. Efficient and effective use of hydro-meteorological and environmental information for making early warnings and seasonal forecasts which feed into long-term development plans. This can focus on improving national and decentralized technical and operational capacities of the recently created Disaster Risk Management Unit (ANPC) and locally-based NGOs/CSOs to disseminate alerts, ensuring that women are also alert recipients. This can include having knowledge transfer sessions where technical information production institutions can teach alert providers how to communicate the technical jargon of weather bulletins and forecasts. In order to have effective alert dissemination, a Standard Operating Procedure (SOP) for communication can be developed. Relevant agencies can also be provided privileged communication equipment (e.g., CB radios) to effectively disseminate alerts. A feedback mechanism (via SMS, toll-free numbers and local focal points) can be provided to ensure that end-users are engaged in communication from the bottom up.

3. Common CSA practices in Benin's farming systems

Benin's review was based on the four clustered areas of priority for CSA namely: Land Restoration and Agroforestry system (LRA), Integrated Soil Fertility and Management (ISFM), Market, Value chain and Micro-finance (MVM) and Crop Diversification (CD) as shown in Table 1. The review was conducted through desktop study of various reports (State Institutions, UNDP, GIZ and FAO) and curricula of institutions of higher learning in the country (University of Abomey-Calavi and National University of Agriculture). The study specifically, identified the policies relevant to CSA, as well as the inventory of existing programs related to CSA in the various institutions of higher learning in Benin. Table 2 presents a compilation of key CSA practices that directly or indirectly lead to improved agricultural productivity, reduced GHG emission and therefore enhanced resilience of food systems. These practices are widely used under various cropping systems in Benin.

TABLE 2: Some common CSA practices in Benin

CSA cluster	CSA Type	Description	Potential
Land Restoration and Agroforestry system- (**LRA)**	Agroforestry	The intentional planting or guarding against the removal of more than one tree within 12 months on agricultural land or from its borders and on land set aside for purposes of tree planting. It manifests through practices such as planting of fruit trees, windbreaks, live fences, planting on boarders, and execution of strip cropping.	Results into sustainable land use management through soil fertility maintenance, creation of favorable microclimates like shade, and reduces moisture-related stress. It also leads to carbon sequestration, soil erosion prevention, and tree products that offer environmental services.
	zai planting pits	Refers to a soil conservation measure put in place to restore a degraded soil. A wall is constructed and filled with organic material	This results into reduced soil fertility loss and increased water infiltration into the soil.
Integrated Soil Fertility and Management (**ISFM)**	Synthetic fertilizers	These are substances of manufactured origin that, when applied to the soil, release one or more critical nutrients needed by plants for growth and increased yields.	Compensates for the declining soil fertility and mostly nitrogen

	Composting or mulching (use of crop residues)	Refers to the collection and heaping of waste materials of either plant or animal origin such as food remains, crop residues, and or animal manure piled in a pit or any other structure to hasten decomposition and application to cropland soil afterward.	Compensates for the declining soil fertility, avoids emissions from the use of raw animal manure, improves soil carbon sequestration and increases productivity with low inputs.
	Intercropping	Refers to the planting of two different but complementary crops on the same piece of land at the same time in a mixed pattern, in rows, or done through strip intercropping. Example: Maize and groundnut	Improves nitrogen fixation and improved soil quality and reduces risks of total crop failure.
	Crop rotation	Is the systematic and planned change of crop plots per season or per year to avoid the depletion of soil nutrients that may occur when the same type of crop is planted in the same area seasonally or year. It entails the farmer choosing to alternate crops that can replenish and or help to fix the nutrients used up by the other; this includes scenarios like planting groundnuts after maize.	Compensates for the reduction in soil fertility, increases resistance to pests and diseases, soil structure improvement, contributes to carbon sequestration, prevents erosion and sustains productivity through soil exhaustion avoidance.
Crop Diversification-(**CD)**	Improved crop varieties	Is the use of genetically and phenotypically improved crop planting materials that have been bred for their traits such as increased yield, tolerance to stress, short duration and disease resistance.	Ensures stress (drought, flood, and heat and cold stresses) tolerance and disease resistance; early maturing that avoids crop loss from shorter growing seasons and unreliable rains. It also results in higher productivity and reduces risks of crop failure.
Market, Value chain and Micro-finance (MVM)	Development of new products	Manufacture and promotion of new agri-food products (fruit juice, vinegar, fermented baobab almonds, pineapple alcohol, etc.;	
	Use of new sources of energy	Recovery of residues from agricultural or other sectors activities that were previously thrown away or under-exploited to make new sources of organic matter for domestic energy (rice husks, palm kernel shell, sawdust).	Reduction of the amount of firewood used and consequently the pressure on forest resources.
	Improved traditional stoves	Innovations aimed at energy efficiency made from traditional stoves to improve their calorific value and reduce energy losses while	Reduction of the amount of firewood used and consequently the pressure on forest resources.

4. Climate Smart Agriculture-Relevant Policies and Strategies in Benin

Benin's agricultural sector is feeling the full brunt of climate change. Life in Benin is being severely impacted by climatic variations, which are manifested by drought and hot weather, irregular rains as well as violent winds followed by heavy rains. As a result, farmers no longer control their production cycle, and they are experiencing a decline in agricultural output, leading to a reduction in overall purchasing power. Therefore, to eradicate poverty in the country the focus should be on building households and livelihoods resilience to shocks; this is essential for ensuring food and nutrition security and sustainable management of natural resources. There is a need to strengthen the capacity of the often-poor rural populations to manage the risks they face and to reduce their exposure and vulnerability in this regard. To adequately face the negative mid-century forecasts, major efforts are underway in the country regarding climate adaptation. Various national strategies, policies and programs are implemented to ensure agricultural development is strengthened. The National Committee on Climate Change (CNCC), a multi-stakeholder platform in Benin, has been created to advance the country's institutional framework on climate change. The CNCC provides support in the formulation of both national and local policies and strategies for combating the negative impacts of climate change. A number of policies and programs related to climate change are being implemented in order to strengthen the resilience and adaptive capacity of food systems and water management (Table 3).

TABLE 3: Policies relevant to agriculture and climate change

Documents	Potential measures for doing so
Strategic Plan for the Development of the Agricultural Sector (PSDSA): Strategic Orientations 2025 & National Plan for Agricultural Investments and for Food and Nutritional Security (PNIASAN 2017 – 2021)	Their actions are based on five priority areas, namely: (i) improving the productivity and production of plant, animal and fish products in the agricultural sectors; (ii) the promotion and fair structuring of Value Added Chains (production, processing, normalization, standardization and labeling, consultation and marketing framework) of plant, animal and fish products from priority sectors; (iii) Strengthening the resilience of farms (sustainable land management and adaptation to climate change, risk management) in the face of climate change and improving the food and nutritional security of vulnerable populations (nutrition, social safety nets, etc.).); (iv) equitable improvement of governance (legal and institutional strengthening, accountability mechanisms and intersectoral coordination at different scales) of the agricultural sector and food and nutritional security; and (v) establishment of financing and insurance adapted and accessible to different types of farms and categories of actors in the links of the agricultural value chains, including women, young people and first-time entrepreneurs
Benin National Adaptation Plan	Its vision is: "Benin is, in 2030, a country resilient to climate change with sufficient adaptive capacity and appropriate mechanisms for anticipating and reacting to climate risks and whose institutions, organizations, businesses and citizens adopt, climate-sensitive attitudes and behaviors". The overall objective of Benin's NAP is to increase the country's resilience and adaptive capacity to climate change. Specifically, the NAP aims to: - Reduce vulnerability to the impacts of climate change by strengthening the adaptive capacity and resilience of local communities and their livelihoods for economic and social transformation at the national level and by 2030;

	- Facilitate the integration of climate change adaptation, in a coherent manner, into relevant policies, programs and activities, whether new or ongoing, in particular development planning and budgeting processes and strategies.
Gouvernement Action Program (PAG) 2016-2021	It has planned several actions and reforms to "sustainably revive Benin's economic and social development" including the development and implementation of adaptation, mitigation and disaster management measures through the continued implementation of implementation of the PANA, forest protection, reforestation and greening initiatives at municipal level, the fight against coastal erosion, a strategy for climate-smart agriculture, the promotion of rational and sustainable management of natural and forest resources, etc.
National action program for adaptation to climate change in Benin (PANA-BENIN)	The aim of the PANA in Benin is to enable the development of a framework for coordination and implementation of climate change adaptation activities in the country, the strengthening of capacities and synergy of the various programs in the field of the environment through a participatory, community and multidisciplinary approach.
Low-carbon and climate-resilient development strategy (2016-2025)	This strategy has been developed according to the vision that “Benin is, by 2025, a country whose development is resilient to climate change and low carbon intensity”. The overall objective of the strategy is to contribute to the sustainable development of Benin, by integrating climate considerations into the country's strategic sectoral operational plans, to make them lower carbon intensity and more resilient to climate change. This strategy is implemented through twelve sub-programs organized around three pillars, respectively articulated around adaptation, climate risk reduction and mitigation.
National strategy for strengthening human resources, learning and skills development to promote green, low-emission and climate-resilient development	Benin's vision for strengthening human resources, learning and skills development to foster green, low-emission and climate-resilient development is as follows: Benin is, in 2025, a country that has sufficient human resources and institutions capable of effectively and efficiently contributing to addressing the challenges posed by climate change, in order to ensure low-emission and climate-resilient development. The overall objective of the Strategy is to contribute to the development of human resource capacities, learning and skills in the field of climate change. Its specific objectives are to: 1. have a sustainable human resource base to deal with climate change; 2. Strengthen the capacities of structures and organizations working in the field of learning and developing skills in the fight against climate change (mitigation) and its harmful effects (adaptation).
National Action Programme to Combat Desertification	The National Action Programme to Combat Desertification (NAP) aims to identify the factors contributing to desertification and the concrete measures to be taken to combat desertification and mitigate the effects of drought. The general objectives are: to strengthen the capacities of the different categories of actors (state, local populations and communities, NGOs and other development associations, private sector) to ensure the sustainable management of natural resources Improve the institutional and legislative framework for combating desertification; improving the living conditions of the population and rehabilitating areas affected by desertification. The NAP envisages measures aimed at: (i)

	strengthening basic knowledge and developing information and observation systems for vulnerable areas; (ii) combating water erosion, including by intensifying soil conservation activities; (iii) developing and strengthening integrated land and water management programmes in the context of the diversification of income sources and the eradication of poverty; (iv) establishing comprehensive plans for prevention and relief in the event of drought. In order to solve the problem of food security, the NAP envisages increasing the production of foodstuffs while ensuring the sustainability of production factors, the increase of productivity and, in particular, the involvement of groups vulnerable social groups such as women and young people.
National forest policy	The overall objective of the forest policy is to contribute to the improvement of the living conditions of the populations of the Benin by promoting sustainable development and rational management of these natural resources. The content of This policy is based on the observation of the strong degradation of natural and forest resources in particular, of a series of shortcomings in the knowledge and management of these resources and the necessary collaboration between all stakeholders. The main objectives assigned to this policy are: (i) Ensure the sustainability of the forest heritage (ii) Integrate the management of forest resources with other sectoral policies.
Environmental Action Plan (PAE)	Developed and implemented since June 1993, constitutes the national policy and strategy on the environment and adopted in June 1994 and aims to: (i) change behavior, in particular by raising the standard of living and raising the awareness of all Beninese, (ii) control of the development of natural resources and better management of biodiversity (iii) improvement of the living environment of all Beninese.

5. The Climate Smart Agriculture technologies and practices identified in Benin and the major constraints to their transfer

In Benin, several CSA technologies and practices are listed. A complementary study by means of a multi-criteria analysis allow to retain five priorities that meet the three pillars of CSA to be scaled up by sub-sector and summarized in the Table 4.

TABLE 4: Climate Smart Agriculture to be scaled up by sub-sector in Benin			
Areas	**Number of technologies listed in Benin**	**Priority technologies to scale-up in Benin**	**Scaling Constraints**
Crop production, improvement/restoration of fertility and soil protection	22	• Use of improved varieties (short cycle and/or drought and disease resistant varieties); • Mulching of crop soils (use of crop residues, polyethylene films); • Improved Production System (SAP): crop rotation on the farm; • Localized irrigation (drip or microdiffuser) ; Sowing management (resowing, overseeding, false sowing, dry sowing, change of sowing date).	• Lack of a research program for the scientific evaluation of practices; • Insufficient capacities of actors; • Insufficient funding mechanisms for research and adoption by stakeholders; • Weak securing land ; • Low commitment of staff in charge of agricultural advice • socio- cultural realities ; • the availability of alternative inputs and specialized labour.
Animal production	08	• Introduction of improved breeds, crossing with local ones for good disease resistance; • Constitution of food reserves for the dry season (hay, silage, etc.); • Use of new food sources (tree legumes, rice straw, etc.); • Crops of resistant fodder varieties; • Seasonal Livestock Mobility Practice	
Fish production	05	• Breeding of fish in ponds; • Introduction of short cycle fish strains (tilapia); • Fish farming in aboveground tanks (BHS); • Fish farming in floating cages and fish enclosures; • Fertilization of ponds fish farms .	
Development of value chains	10	• Manufacture and promotion of new agri-food products (fruit juice, vinegar, fermented baobab almonds, pineapple alcohol, etc .; • Use of new sources of organic matter for domestic energy (rice husks, palm kernel shell, sawdust); • Traditional hearths improved ; • Steam cooker for local dishes; • Dryers solar	

Forestry	12	• Plantations/reforestation (state, communal or large-scale including mangroves using mangroves and fast-growing species; • Improved management practices (plowing, mowing, thinning, control of animal and plant pests) of plantations and forest parks); • Alley cropping/agroforestry (annual crops between rows of trees); • Domestication and planting of local fruit species adapted to the climate; • Water and soil conservation.	

6. Review of past and on-going CSA project in Benin

Since the end of the 2000s, Benin has invested a lot in a structural way to undertake actions in its rice production sector through the development of smart-irrigation. Various other adaptive actions, sometimes less structured, are also taking place in the country. More recently, with the support of some technical and financial partners, several CSA projects are being implemented in the country. Some examples are reported in the Tables 5 and 6.

TABLE 5: Profiles of adaptation projects financed from the national budget

Sector	Title	Main Objective	Cost (Us$)	Term
Agriculture and Food Security	P1- Establishment of a climate risk forecasting and early warning system for food security in 4 vulnerable agro-ecological zones	Provide stakeholders and farming communities with notices and alerts in the event of significant meteorological and climatological events announced that are harmful to production systems	8.190.000	6 years
Energy	P2- Adaptation of households to climate change through promotion of renewable energies and efficient economic stoves and pressure cookers in areas vulnerable to climate change and whose land is highly degraded	Reduce the vulnerability of populations to the effects induced by climate change by improving access to renewable energy sources and safeguarding forest resources	2.106. 600	3 years
Water Resources	P3- Mobilization of surface water for adaptation to climate change in the most	Strengthen the availability of water during dry periods for the purpose of adapting	2.875.000	3 years

	vulnerable municipalities of the Center and North departments	populations to climate change		
Health	P4- Protection of children under 5 and pregnant women against malaria in areas most vulnerable to climate change	Contribute to the reduction of morbidity and mortality linked to malaria in Benin	1.112.500	3 years
Costal zone	P5- Protection of the coastal zone against sea level rise	Correct sediment imbalance, beach depletion and retreat, restore mangrove and promote improved salt mining technology combining solar and wind energy.	1.296.000	5 years
TOTAL			**15.580.100**	

TABLE 6: Past and on-going CSA project in Benin funded by technical and financial partners

Title of project	Responsible	Location	Duration	Budget	Objective
Strengthening the Resilience of Rural Livelihoods and Sub-national Government System to Climate Risks and Variability in Benin	Partnership and Expertise Center for Development (CePED), Global Environment Facility and UNDP		from 2017 to 2022	US$34,950,000	Project is intended to build the capacity of municipalities, departments, and all relevant ministries to integrate climate change risks and opportunities into development planning and budgeting processes; reduce the vulnerability of targeted communities to the negative impacts of climate change through technical training and smart investments in agricultural production and water management infrastructure; and improve the adaptive capacity of targeted communities by supporting the

					diversification of their income-generating activities.
Adapting agriculture to climate change (PACC)	GIZ	three selected communities bordering on the Pendjari and W National Parks in northern Benin	from 2014 to 2019	-	The aim of this project was to improve the resilience of agricultural systems and the individual farms in the water catchment areas to climate change. The implementation of the protection and usage regulations in the management plans reduced the pressure on the natural resources of the neighbouring national parks. In this way, the project also contributes to preserving biodiversity in the region.
Green Innovation Centre for the Agri-Food Sector" (ProCIVA)	BMZ and SDC	The project operates in three value-added chains (VACs) upstream and downstream of production: rice, soybeans and poultry.	October 2014 to March 2023	25,600,000 EURO	The overall objective is to improve the incomes of small farmers, employment and regional food supply through the implementation of innovations in the agricultural and agrifood sector in selected rural communities in Benin
Benin Rice Sector Support Project (PAFIRIZ)	Financed by a contribution from the European Union (EU) under the 10th EDF. The Belgian Development Agency (BTC) provides technical assistance for its	Departments of Atacora, Atlantique, Collines, Couffo, Donga, Mono, Ouémé, Plateau, and Zou.	2009-2013	€5,420,000,	The Benin Rice Sector Support Project (PAFIRIZ) aims to fight against poverty and food insecurity. In a medium-term perspective, the project aims to contribute to two objectives: limit Benin's dependence on

	implementation.				food imports through the development of the national rice sector and increase rural incomes.
The Project "Protection and Rehabilitation of Degraded Soils to Improve Food Security" (ProSOL)	is one of the projects of the Special Initiative entitled "ONE WORLD without HUNGER" of the German Federal Ministry for Development Cooperation.	ProSol operates in eighteen (18) municipalities and 450 villages in the departments of Zou, Collines and Borgou, through private agricultural advisory services.	2014-2019	41,30million EURO	The main objective of "ProSol" is to strengthen the technical capacities of small/smallholder farmers for the implementation of sustainable land management and climate change adaptation measures on their farm. To achieve this objective, the project trained, supported and monitored smallholders and women farmers for the implementation of SLM measures: Water and Soil Conservation (CES), Integrated Soil Fertility Management (ISFM) and Defense and Soil Restoration (DRS).

7. Course Units Related to CSA in Benin's Universities' Degree Programs

In line with the new challenges, particularly the biggest of the 21st century, climate change, various institutions of higher learning in Benin are increasingly integrating climate change adaptation in their degree programs, and particularly courses that are related to CSA (Table 5). Benin hosts the regional PhD program in Climate change and Water Resources financed by WASCAL (West African Science Service Center on Climate Change and Adapted Land Use). This program is located at the University of Abomey-Calavi.

TABLE 5: Agriculture, Animal and Forestry Sciences Programs with elements of CSA in the various institutions of higher learning in Benin

University of Abomey-Calavi			
LRA	**CD**	**ISFM**	**MVM**
Ecological Restoration and Climatology (REC-7315)	Protection of Agricultural Production (PPA-7004)	Soil Fertility and Post-Harvest Conservation (SCR-7004)	Agricultural and agri-food techniques (STG-7003)

Animal Production System and Agroforestry (SPA-7215)	Crop and Weed Management (CCH-7115)	General Pedology and Agriculture (PAG-7002)	Accounting and Agricultural Business Creation (CEA- 7515)
Ecological restoration & Water and soil conservation (REC-1505)	Seed and Plant Production (PSP-7115)	Fertilization Techniques (TFE-7115)	Processing of Agricultural Products (TPA-7525)
Ecology of Rangelands and Ecological Restoration (GRN-7402)	Genetic improvement of plants	Storage and conservation of agricultural products	Agricultural accounting
Meteorology and weather data management (ENV-7332)	Agricultural Products Processing (TPA-7525)	Soil Fertility and Plant Nutrition	Marketing of Agricultural Products
Principles for the domestication of agroforestry trees (BIC-7423)	Storage, Preservation, Quality and Standards of Agricultural and Food Products (SCQ-7525)	Horticulture and Organic Fertilizers (HEO 7115)	Agricultural Finance (EGC-7003)
Climate Change and Agriculture (CCA-5246)			Traceability and Regulation of Agricultural Products (TRE 7115)
Agro-meteorology			Economics of agricultural and agro-industrial value chains (MFA 7515)
Water Control (MEA-7003)			
National University of Agriculture			
Land Evaluation and Land Use Planning (1 GDT 2203)	Climate Change and Agriculture (1 CCD1402)	Soil Characterization and Classification (1 SCS 1207)	Marketing of Agricultural Products (2 MDP 1512)
Hydrology (3 SPC 1201)	Climate-Smart Agriculture (2 DDC 1402)	Soil Fertility and Plant Nutrition (2 SCS 1207)	Market of input suppliers (1 MDP 1512)
Irrigation and Drainage (2 MEP 1504)	Agroclimatology and Clinate change (1 CME 2201)	Biologic Horticulture (HOB 2301)	Management of rural and agricultural credit (2 GES 2110)
Farming Systems and Agroforestry (1 VPF 1404)	Sustainable Development (2 CCD 1402)	Integrated Organic Farming Systems (3 DDC 1402)	Agricultural Finance (FAF 1521)
Forest Restoration (RF O1502)	Vegetable, fruit and flower production (2 HOB 2301)	Soil Pollution and Conservation (GDS 2303)	Risks and Agricultural Insurance (2 FIN 2310)
Agroforestry and Land Use (1 GDT 2203)	Plant breeding (1SBA 1301)	Soil Biology and Biochemistry (MSN 2206)	
Climate change and green economy (1 CDD 2202)	Seed science and technology (TMP 1503)		
Rangeland Resources Management	Plant Resistance to stress & Climate Change		

(2 SLPA 2105)	(RPS 2103)		
Tree production (2 EFO 1306)	Food security, livelihoods and nutrition (PTA 1304)		
	Mitigation and Adaptation Strategies in Agriculture (2 CCA 1403)		

8. Training gaps on CSA in Benin

The training gap on the climate smart agriculture in Benin is summarized in the Table 6.

TABLE 5: Training gaps on CSA in Benin

Training theme	Description	Beneficiaries	Priority level
Lack of practical understanding of the CSA approach.	The CSA and CIS approach is obviously attractive and compelling in principle, but its application in the context of diverse agro-ecologies and highly heterogeneous farming systems, conditions and socio-economic policies in Benin still requires concrete success stories. Gathering clear empirical messages to inform farmers and policymakers and support scaling-up initiatives will depend on how well the CSA concept is understood in practice, allowing for continuous two-way adaptations and feedback mechanisms between researchers and practitioners, farmers and policymakers.	Staff and students	High
Capacity building on the adequate and innovative financing mechanisms and effective risk-sharing systems.	As farmers in Africa face major risks from the effects of climate hazards, they also face the challenge of managing the risks associated with the high costs (at least the initial costs) of adopting new technologies (e.g., conservation agriculture and agroforestry), the benefits of which often only become apparent after several years/seasons of production. Most farmers have little or no access to credit, microfinance, and/or insurance.	Students	High
Improve policy coordination and strengthen local, national and regional institutions to support implementation of CSA and CIS	Without appropriate institutional structures in place, CIS and CSA-related innovations can overwhelm smallholder farmers. Strong institutional support is needed to: promote inclusion at the decision-making level; improve information dissemination; provide financial support and access to markets; provide insurance to address risks associated with climate shocks and the adoption of new practices; and support farmers' collaborative actions.	Staff	High
Climate information service and real-time agricultural data	Due to the increasing number of disasters and weather extremes in Benin, there is a need to increase access to climate information services for the different stakeholders.	Staff and students	High

Research and Education for the Development of Integrated Crop-Livestock-Fish Farming Systems	There is a pressing need to increase the productivity and profitability of fish farming in Benin. For example, most aquaculture promoters understand and see only the fish and their requirements and do not take into account the complete resource system.	Students	High
Economics of Climate Change	Considering that solving environmental problems will require behavioral changes, it is important that economic planners as well as business entities fully understand agrifood economic requirements and ways to influence it within the concept of sustainable agriculture in its relation with climate change challenges. As such, train students on in-depth understanding of climate change economics, and discuss behavioral, economic, and sociological aspects of food security, sustainability, and social responsibility that affects the overall economic decision making processes.	Staff and students	High
GIS Applications in Climate Change, Sustainable Agriculture and Food Security	Need of enriching the knowledge of the graduate students in the fields of GIS applications in the areas of climate change, sustainable agriculture, and food security. Special attention need to be given to spatial analysis and its implementation in real world, particularly in land and water management issues that are directly linked to CSA	Staff and students	Medium
Applications of Biotechnology in CSA	There is a need to learn about the science behind biotechnology application in area of CSA. This include employ biotechnology to enhance crop productivity and quality; Build positive attitude concerning bioethics in relation to biotechnology.	Staff and students	High
Climate Smart Food Value Chain inAgricultural Food System	The training shall focus on an approach that simultaneously focuses on, or achieves, increases in agricultural yields, improved resilience or adaptation to climatic changes and variability, and reductions in agricultural greenhouse gas emissions	Staff and students	Medium
CSA and CIS-oriented extension strategies	Staff and students need to be equipped on the most appropriate extension strategies to increase chance of CSA and CIS practices' uptake by farmers	Staff and students	High
Digital-based platforms for plant and animal disease monitoring and control	With the increasing volume of data being generated across the country and the opportunities provided by the communication technologies, it is important to equip staff and students on how digital platforms could help for timely monitoring and information sharing on emerging animal and plant diseases.	Staff and students	Medium
Bee-friendly management of biodiversity	This CSA practice focuses on promoting interventions to reduce the risks for bees and other pollinators from agrochemicals in order to assure their survival and long-term services for crop productivity and sustainability. There is a need to strengthen the capacity of the farmers.	Staff and students	High
Gender issues and CSA in Benin	Staff and students need more awareness on how women can be sustainably supported through a community-centered approach to adopting and adapting livelihood strategies in innovative ways,	Staff and students	Medium

	based on current and future climate change scenarios.		
Information and Communications Technology (ICT) and CSA practices dissemination	These technologies have been instrumental in disseminating CSA practices and climate information in other African countries. Yet, these are still unknown in Benin and lack in the university curricula.	Staff and students	Medium
Agricultural waste recycling options	Fortunately, there are other methods of agricultural waste disposal, such as composting and recycling which can be implemented to help protect the environment. For example, organic fertilizers can be used again and again, and animal waste (faeces) can be used in composting. Adding economic and eco-friendly recycling options in the curricula is important.	Students	Medium
Microdosing and micro-irrigation systems	The application of fertilizer and water is often inefficient due to misuse of products and the dosage is not well mastered by farmers. Training students on microdosing and micro-irrigation systems would help fix the situation in the near future.	Students	Medium
Crop diversification and climate-resilience potential of neglected and underutilized crop species	Neglected and underutilized crops, as the most adapted to local agricultural systems and climates, are now perceived as a mean to minimize adverse effects of climate changes. Yet, their knowledge is poor among staff and students.	Staff and students	Medium
Conservation and enhancement of biodiversity and ecosystem services	Ecological restoration is widely used to reverse the environmental degradation caused by human activities. However, there is a lack of skill on effectiveness of restoration actions in increasing provision of both biodiversity and ecosystem services.	Staff and students	Medium

Conclusion

This study identified and assessed climate-smart agricultural practices and technologies in Benin. There are several climate change adaptation practices/technologies developed by farmers or popularized by projects. The adoption and use of these technologies depends on the financial means and capacities of producers. These recommendations are made according to the different agro-ecological zones for the improvement and scaling up of the identified good practices for climate smart agriculture in Benin. For more effective CSA practice in Benin, it will be quite interesting to explore and promote in the near future:

- Integrated agricultural systems and landscapes that incorporate crop, livestock and fish production, as well as forestry need further.
- Enhancement needed for other off-farm services related to CSA (climate-services, and index-based weather insurance)
- Enhancement of CSA-related input and output markets is required.

✓ *in the livestock sector*

- introduction of high-value species or crossbreeding with local breeds,
- conservation of animal feed for the dry season,
- use of resistant varieties of fodder and

- seasonal livestock movement to find water and pasture.
- Fish production: use of fishponds, tanks and floating cages; introduction of short-cycle fish species; and fishponds fertilization

✓ *CSA practices in the forestry sector*

- improved forest management,
- agroforestry, and the planting of local fruit trees adapted to climate.

✓ *Off-farm CSA-related practices*

- use of clean energy (biogas)
- use of organic matter for domestic energy
- use of improved traditional stoves.
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Improved CSA governance system needed

Various stakeholder institutions, strategies, policies and programs are implemented in the field of agriculture and climate change. Coordination among policies, sectors and institutions will be crucial for sustained adoption of CSA practices in Benin.

Funding for climate-smart agriculture

- generally limited and unfocused
- Efforts underway to ensure that Benin can access and utilise international climate finance from sources such as the Green Climate Fund (GCF), through readiness and capacity building programmes.

Existence of the mechanism of the National Fund for Environment and Climate (FNEC) which targets and finances CSA activities related to reforestation, agriculture and livestock.

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About AICCRA

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