CLIMATE SMART AGRICULTURE (CSA)-CLIMATE INFORMATION SERVICES (CIS) PRIORITIZATION IN GHANA: SMARTNESS ASSESSMENTS AND OUTCOMES

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About AICCRA Ghana Cluster

AICCRA-Ghanafocuses on bridging the gap between the research institutes that produce improved technologies and the development organizations that promote the adoption of improved technologies including digital Climate advisories, for the purpose of enhancing the resilience of the country's agriculture and food systems in the face of climate change while improving livelihoods of hundreds and thousands of farmers. AICCRA-Ghana mutualizes existing expertise to strengthen the technical, institutional, and human capacity needed to move CGIAR innovations off the shelf and achieve impacts in the country. The project will specifically launch a "One-health platform for climate-driven pests and diseases". It is an advanced climate-informed One-health innovation that builds on CGIAR's track records in this area, framing the nexus of the crop, livestock, soil, and water health for improved human and ecosystem health, food safety and nutrition, and climate change as a complex public health issue. The project is anchored to CGIAR's multi-stakeholder platform of the Biorisk Management Facility (BIMAF) hosted by IITA's station in Benin, West Africa. AICCRA-Ghana will use the CGIAR's Scaling Readiness Tool to undertake assessments of CSA options for accelerated uptake of innovations. NFCS and innovation platforms including the private sector, Nourishing Africa network, and farmers will be

capacitated towards identification, promotion and implementation of suitable CIS and best-bet CSA and One-health innovations. Media and mass-campaign awareness will be launched while developing business models and engaging champion women- and youth-led enterprises. Pilot sites will be identified and training provided to farmers for successful implementation of One-health and CSA technologies.

ABSTRACT

Climate change continoulsy affects efficient farm productivity among smallholder famrers in Ghana and other parts of West Africa. Efforts have been made by farmers and policy makers in mitigating the effects of climate change on livelihhods. Hitherto, these efforts lacked complementarity and adhoc in adaptation among worst affected areas. Advancement in CSA practices therefore called for prioritization based on identified enablers in commodity value chains and within geographical areas. These enablers under the AICCRA-Ghana project consist of climate smartness (mitigation, adaptation and productivity), gender and social inclusion (labour requirements, youth involvement and women friendliness), achieving one-health (pest load reduction, soil nutrient improvement, reducing soil-water pollution, promoting crop-livestock integration, lowers GHG emissions, contributes to lowering incidences of disease to humans, and preserves biodiversity), and addressing end-user friendliness (technical feasibility, and cost effectiveness among male and female end-users). On-farm composting, organic amendment to improving soil fertility, enhanced biopesticide use in potato system, promotion of disease and pest tolerant varieties and vine technology were the top 5 prioritized CSA practices for AICCRA intervention for the Central region. Promotion of disease and pest tolerant maize, cowpea and yam varities, minimum tillage, seedbed options with ridging as an alternative to mounding, water management (mulching), and promotion of drought, early maturing, and striga resistant seed varieties were CSAs prioritized in the Bonno East region. Northern, North-East and Savanna regions of Ghana identified minimum tillage, mucuna pruriens or cowpea/maize intercropping-yam rotation to build soil Carbon stocks, leguminous crops as previous crop to yam and maize, organic amendment for improving soil health, and promotion of stress (drought, early maturing, striga and low N) tolerant improved maize, cowpea, yam and potato varieties were prioritized. Specifically to the Climate Smart Villages (CSVs), leguminous crops as previous crop to cereals and promotion of disease and pest tolerant seed varieties were simultaneously given high priority. Enhanced biopesticide use in maize, cowpea, potato and vegetable systems, mucuna pruriens or cowpea /maize intercropping to build soil C stocks, minimum tillage for maize and cowpea and vegetable production, water management (mulching) and promotion of stress (drought, early maturing, striga and low N) tolerant improved varieties were prioritized in the Upper West and Upper East regions along maize, cowpea and tomato value chains. Due to the complementary nature of CSA-CIS practices, 5 bundles were created and common products for sustainable financing included improved and drought tolerant seeds, water management (small scale irrigation), seasonal calenders and soil fertility improvement products.

BACKGROUND

There is growing concern on the diminishing role of agriculture as the driver of developing economies added to the crucial role it plays in livelihood and economic development. Hitherto, the agriculture sector employed about 60% to 80% of the active population in developing countris (Huyer, 2016). Although the sector is faced with numerous challenges ranging from dwindling financial investment and reduction in productive and fertile lands, growing incidence of climate change is intercrting with multiple stressors of the agricultural sectors (Partey et al., 2018; CCAFS, 2021). Several approaches and strategies have been experiemtnted in climate change hit areas especially in South Saharan African countries towards enhancing resilience and farm productivity but evidence has shown a low and challenged uptake and adoption of the past interventions. Current climate change events calls for complementary efforts which will enhance dapation, mitigation and increased productivity. Complemtary attributes of climate change interventions furher requires a multisectoral approach that will enahnce soil, water, animal and crop health during implemmtations of climate change interventions. As part of efforts aimed at accelerating a one-health-led uptake of Climate Smart Agriculture (CSA) in Ghana, the Accelerating the Impact of CGIAR Climate Research for Africa (AICCRA) seeks to enhance access to climate information services and validated climate-smart agriculture technologies in Ghana.

With the support of AICCRA project, farmers and livestock keepers will be able to better anticipate climate-related events and take preventative actions, with better access to climate advisories linked to information about effective response measures. This will help communities better safeguard their livelihoods and the environment.

The Need for CSA-CIS Prioritization

As an entry point to the AICCRA-Ghana implementation strategy of the various components of the project and with emphasis on technology identification and upscaling, a conscious effort has been made at identifiying and consolidating the exisiting Climate Smart Agricultural (CSA) and climate Infoormation (CI) practices in Ghana with emphasis on maize, cowpea, roots and tubers, and the vegetable value chains. These practices were identified based on the various geographical areas in terms of Northern, Upper West, Upper East, Bono East and Central regions of Ghana. These CSA-CIS practices were proposed and identified by actor such as farmers, researchers, agricultural extension agents, and staff of Non-governmental organizations. In all, a total of 22 CSA-CIS practices were identified based on the needs of the end-suers and along commodity value chains.

DATA AND METHODOLOGY

CSA-CIS Practices Identification Process

As part of AICCRA proposition of building on exisiting and past climate change interventions in the the various communities, a database of existing CSA practices was compiled by the various AICCRA-Ghana implemmting partners and other collaborators. This led to a compilation of various CSA-CIS practices in the various geographical locations which includes Northern (Tolon, Worbogu and Yiziegu), Upper East (Tampula and Bongo), Upper West (Boompari, Dzuuri and Doggoh), Central (Amamoma, Effutu Koforidua, Dominase, Ayinase) and Bono East (Adomano, Bawakura, Adiemra, Agygyemakuma, Offuman, Droboagya) respectively. These practices were based on the needs of maize, cowpea, yam, potato and tomatos in these communities. Below are the CSA practices identified by the various actors within the AICCRA-Ghana intervention areas.

1. Minimum tillage for maize, cowpea and vegetable production
2. Biological soil and seed treatment (Application of neem leaf powder to treat soil and ash to treat seed yam before planting
3. Seedbed options-Ridging as an alternative to mounding for yam production
4. Staking Options-Trellis/Minimum staking to reduce deforestation in yam production -
5. Mucuna pruriens or cowpea /maize intercropping-yam rotation to build soil C stocks
6. Leguminous crops as previous crop to yam
7. Organic amendment for improving soil health
8. Promotion of stress (drought, early maturing, striga and low N) tolerant Improved maize, ssscowpea varieties
9. Promotion of Provitamin A and quality protein improved maize varieties
10. Promotion of disease and pest tolerant maize, cowpea, potato and tomato varieties
11. Promotion of Phosphorous efficient and Nitrogen fixing cowpea varieties
12. Promotion of dual-purpose cowpea (grain and fodder)
13. Water management (mulching)
14. Contour stone bunds or contour tillage with tied ridges (Zero or minimal rates of rainfall run-off and soil erosion)
15. Maintain and promote on-farm trees/ agroforestry in cowpea, maize, yam and vegetable farms
16. Mixed/Integrated crop-livestock systems (cowpea, maize, tuber residues for livestock feed)
17. Enhanced biopesticide use in maize, cowpea and vegetable systems
18. Enhancing access to climate information
19. Promotion of On-Farm Composting
20. Vine technology (cutting and planting)
21. Biocontrol of the sweet potato beetle
22. Promotion of vine multiplication technologies (aeroponics and hydroponics technologies)

CSA-CIS Practices Prioritization

As the next step towards effective implementation of the AICCRA-Ghana project, identifying the best-bet practices for continous uptake and implementation within the intervention areas required given priority to practices that meet certain criteria in the intervention communities. This therefore led to conceptualization of enablers towards end-user acceptance and ease of usage. These enablers was based on the contribution of a given CSA-CIS practice to contribute towards mitigation, adaption and enhance productivity. Ghana partners in cloase collaboration with the Gender and Social Inclusion (GSI) components of AICCRA expanded the critera to address the needs of women and the youth in the intevenening commnuties and hence an expanded criteria for prioritization. Based on this, four broad themes which includes 1) Climate Smartness, 2) Gender and Social Inclusion (GSI), 3) Contribution to One-Helath and 4) End-User Friendliness were classified.

Climate smartness consist of three indicators for assessing the CSA pillars and comprised of i) Productivity, ii) Adaptation and iii) Mitigation. The indicators illustrate the potential for the practice to generate positive effects for the farmer in the context of the 3 pillars. GSI comprised of 4 indicators and includes i) labour requirement , ii) youth involvement, iii) lower costs and iv) women friendliness. The women friendliness is further unpacked into lower associated drudgery, accessibility, affordability, socio-cultural appropriateness of the practice, and lower implementation requirements. Interms of a CSA-CIS ability to contribute to one-health by enhancing soil, water, animal and crop health, 6 indicators notably: reduced pest load, addressing nutrient depletion, increased soil water adequacy, and addressing soil water pollution were captured.

AICCRA-Ghana partners in closed collaboration the GSI team further unpacked the "End user acceptance and requires less complementary activities" as the “Enabling Environment” and broken down into 4 sub-indicators e.g., acccess to local institutions; market linkage, technical feasibility and farmers investment capacity to adopt a given practice. Results of the prioritization was analysed using a 5-point Likert Scale in terms of 1 = very low importance, 2 = low importance, 3 = medium importance, 4 = high importance and 5 = very high importance. Tables 1- 4 below shows details of the criteria used in the prioritization process. These four broad thematic areas were further categorized into a 12-point crtiteria in terms of:

Table 1: Climate Smart Pillars for CSA-CIS Practice Prioritization

Climate Smartness (*Three indicators for assessing the CSA pillars considered are Productivity, Adaptation and Mitigation. The indicators illustrate the potential for the practice to generate positive*)		
Score against CSA Pillars		
Productivity	**Adaptation**	**Mitigation**

Table 2: Gender and Social Inclusion Criteria for CSA-CIS Pratices Prioriotization

Gender & Social Inclusion (The One Health Achievement has 6 indicators notably: reduced pest load, addressing nutrient depletion, increased soil water adequacy, addressing soil water pollution,)									
Labour Requirement		Youth Involvement		Women Friendliness					
Male	Female	Male	Female	Lower associated Drudgery	Availability	Accessibility	Affordability	Socio-cultural acceptability	Lower Implementation requirements

Table 3: One-Health Achievement Criteria for CSA-CIS Practices Prioritization

One-Health Achievement (requires less complementary activities" as the "Enabling Environment" and is broken down into 4 sub-indicators)							
Reduces Pest Load	Addresses Nutrient Depletion	Addresses Soil Water Adequacy	Addresses Soil-Water Pollution	Promotes crop livestock integration	Lower GHG emissions	Public Health Implications - contributes to lowering incidences of diseases to humans.	Preserves Biodiversity

Table 4: End-User Friendliness Criteria for CSA-CIS Practices Prioriritization

End-user friendliness (*4 indicators are proposed: Labour requirement , youth involvement, lower costs and women friendliness. The women friendliness is further unpacked into lower associated drudgery, accessibility, affordability, socio-cultural appropriateness of the practice, and lower implementation requirements*)			
Technical feasibility		Lower Associated Cost (Cost-Effectiveness)	
Male	Female	Male	Female

RESULTS AND DISCUSSIONS

Outcome of CSA-CIS Practice Prioritization

Results of the prioritization identified CIS as a cross-cutting practice and services required by all farmers within a various commodity value chains. This was based on the argument that irrespective of the technology used by a farmer and other actors, quality and real time climate information is required for an efficient use of CSA practices. Access to climate information at all levels of commodity values assist in efficient decision making which enhance technology uptake and adoption (Hewitt, Stone and Tait, 2017; Singh et al., 2018).

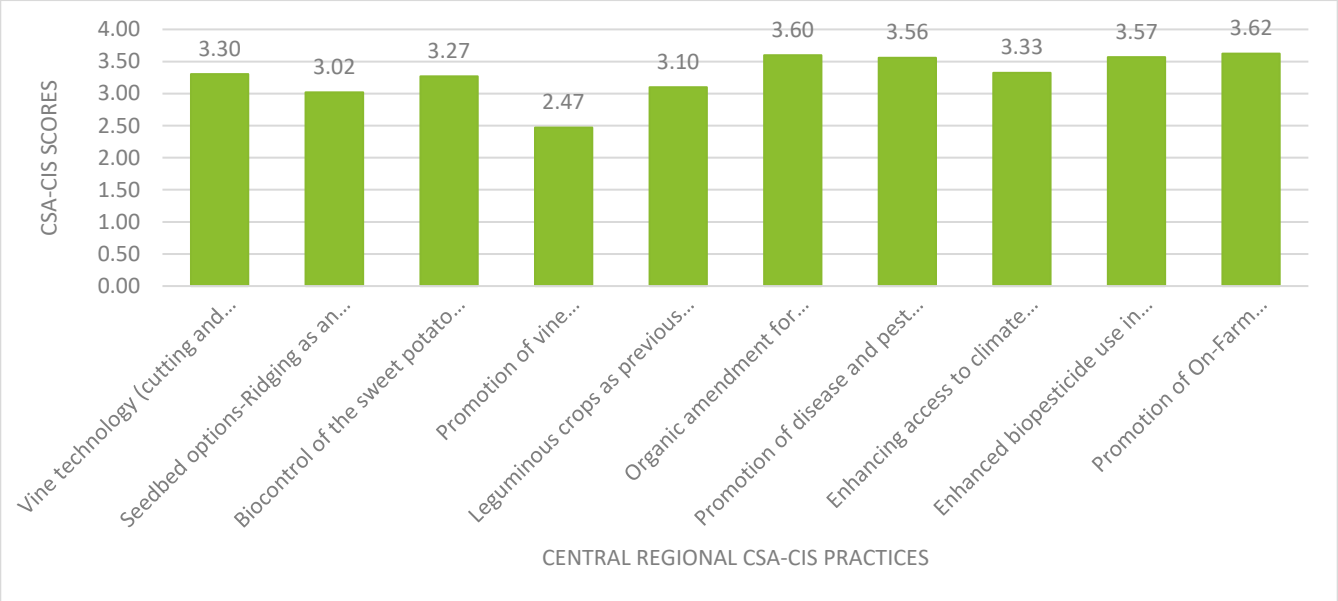

Figure 1: Central Regional CSA Prioritzation scrores

As shown in Fig 1 above, promotion of on-farm composting was prioritized among respondents in the Central regional where potato is the identified value chain commodity to be promoted. Organic amendment for improving soil health, enhanced biopesticide use in potato systems, promotion of disease and pest tolerant potato varieties and Vine technology (cutting and planting) were the other CSA practices idneitified and prioritized in order of relevance and acceptability. This indicates AICCRA-Ghana should focus on capacity enhancement and facilitation of on-farm composting which augments organic amendments to soil health as a component of the one-health apprpproach to reducing the impact of climate change on root and tuber production.

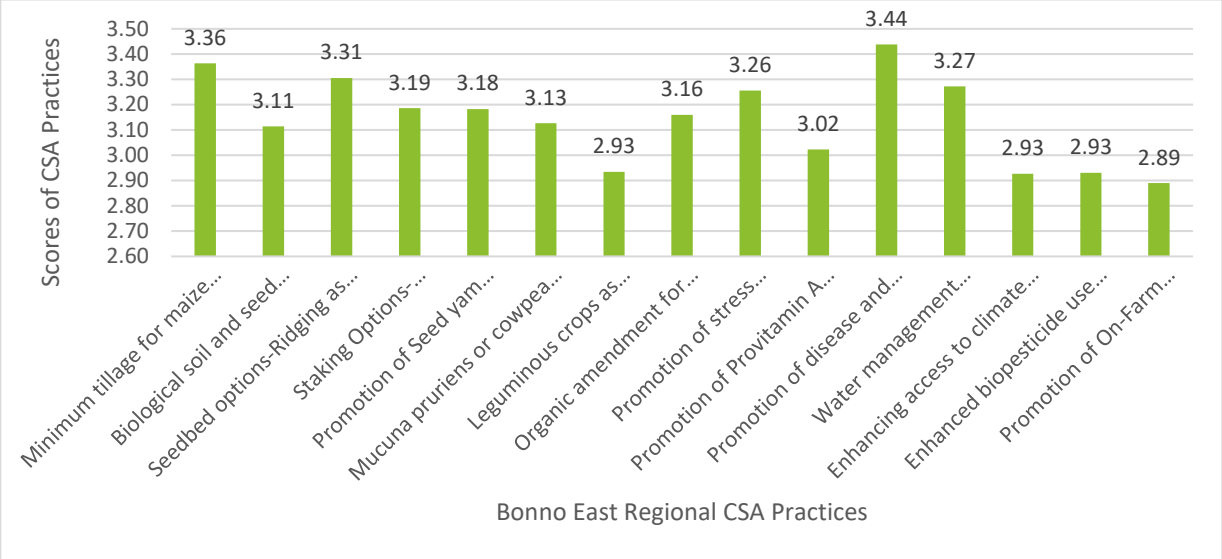

Figure 2: Bonno Regional CSA Practices Prioritization Scores

Respondents from the Bonno East region which was identified as a predominantly maize and yam producing area identified the promotion of disease and pest tolerant maize, cowpea and yam varities as the first pririoty CSA practice. This was followed by minimum tillage, seedbed options with ridging as an alternative to mounding, water management (mulching), promotion of drought, early maturing, and striga resistant seed varieties, staking Options-Trellis/Minimum staking to reduce deforestation in yam production and promotion of Seed yam multiplication technologies (mini-sett technology; aeroponics and hydroponics technologies) in order of prioritization. This is shown in Fig 2 above. This indicates that, respondents in the Bonnno East region focused on improved and drought tolerant seed varieties as a approach to reducing the impacts of climate change in the area.

As shown in Fig 3 below, average scores for the CSA-CIS prioritization for the Northern, North-East and Savanna regions of Ghana identified minimum tillage as a pririoty CSA practice to be prmoted. This was attributed to the nature of the soils which is largely sandy-loamy with high level of erasion. In order of pririotization, mucuna pruriens or cowpea/maize intercropping-yam rotation to build soil Carbon stocks, leguminous crops as previous crop to yam and maize, organic amendment for improving soil health , promotion of stress (drought, early maturing, striga and low N) tolerant improved maize, cowpea, yam and potato varieties, promotion of disease and pest tolerant maize, cowpea, yam and potato varieties and promotion of dual-purpose cowpea (grain and fodder) for human and livestock feeding respectively.

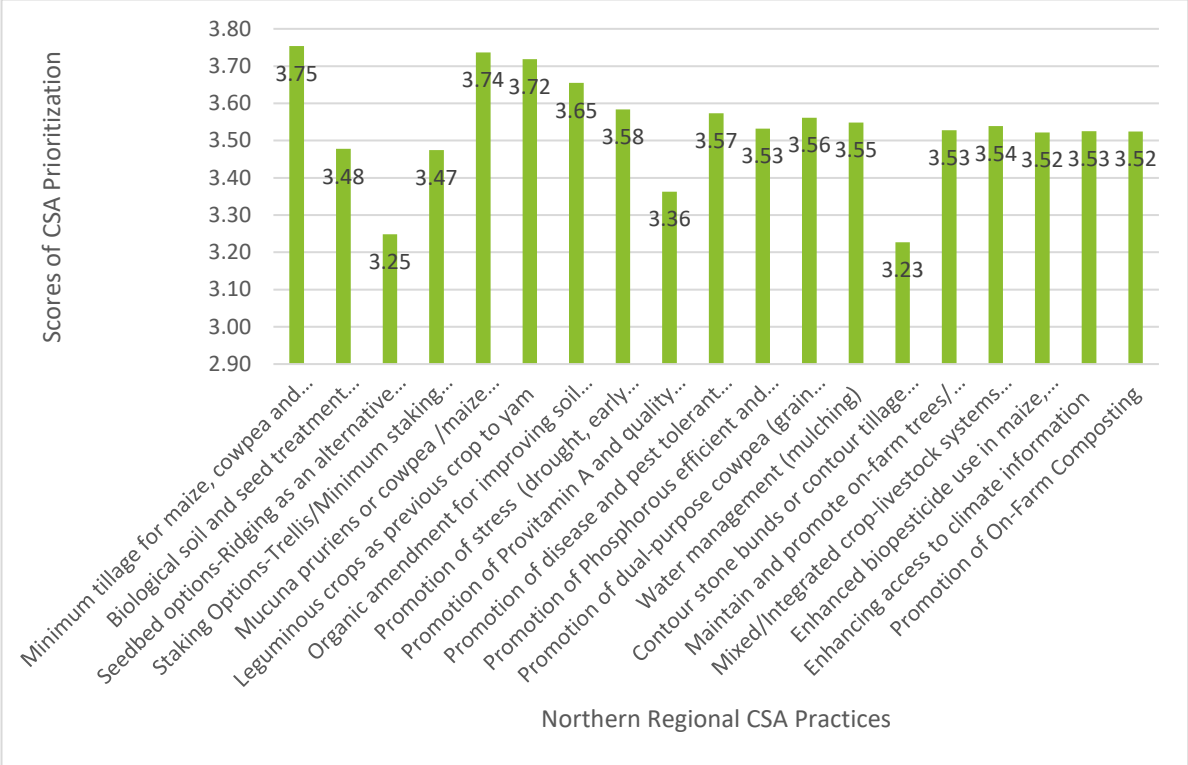

Figure 3: Northern Region, North-East & Savanna Regional CSA Practices Prioritization Scores

Leguminous crops as previous crop to cereals and promotion of disease and pest tolerant seed varieties were simultaneously given high priority. Enhanced biopesticide use in maize, cowpea, potato and vegetable systems, Mucuna pruriens or cowpea /maize intercropping to build soil C stocks, minimum tillage for maize and cowpea and vegetable production, water management (mulching), promotion of stress (drought, early maturing, striga and low N) tolerant improved varieties and promotion of Phosphorous efficient and Nitrogen fixing cowpea varieties were orderly prioritized for uptake and utilization. Mixed/Integrated crop-livestock systems (cowpea, maize, tuber residues for livestock feed) and romotion of On-Farm Composting were the least prioritized although on-farm composting and stone-bunding are the most practiced CSA approach in the Doggoh, one of the Climate Smart Villages (CSV) sunder the CCAFS project.

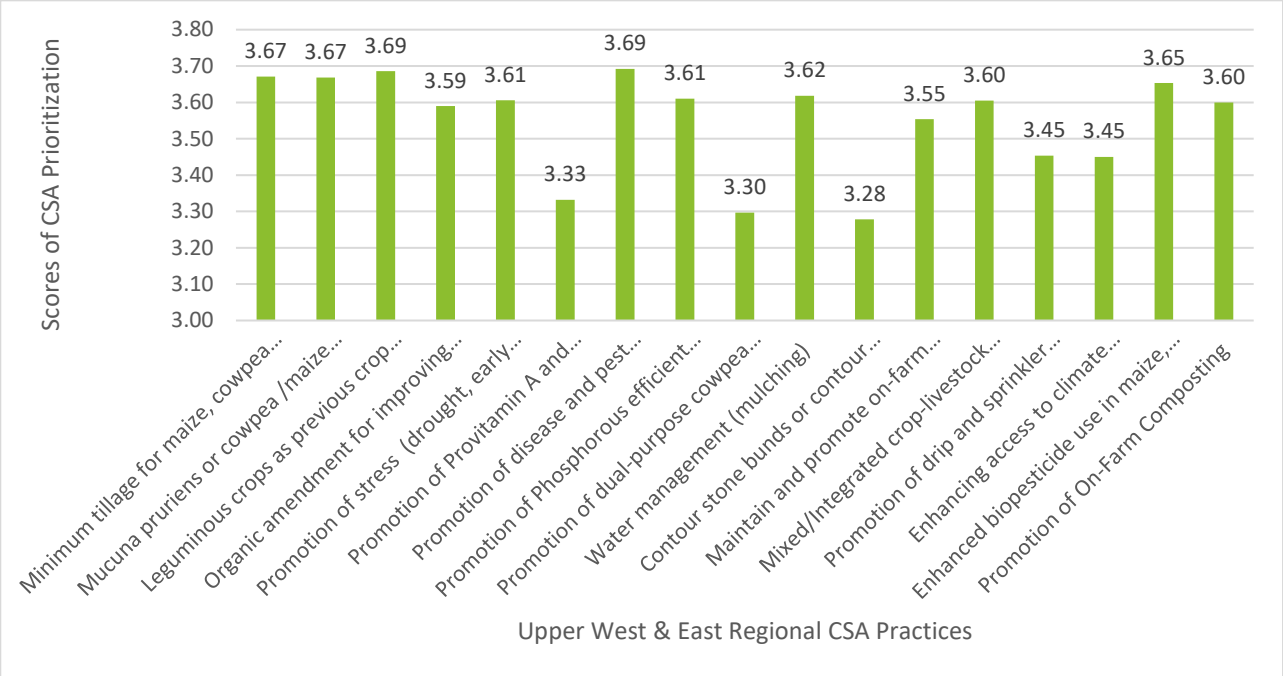

Figure 4: Upper East & Upper West Regional CSA Practices Prioritization Scores

SUSTAINABLE FINANCING

Climate Smart Agriculture (CSA) and Climate Infirmation Services (CIS) are gernaally complementary in nature and an indication that, these practices requires other practices to achieve mitigation, adaptation and increased productivity. As such, AICCRA-Ghana prartners subjected the top-five prioritized CSA practices to bundling process based in line with the maize, cowpea, yam, potato and tomato value chains in the various regions. CIS was considered a cross-cutting practice since usage and practice is irrespective of a bundle and a geographical area.

CSA-CIS Practice Bundling Process

This stage of the Technical Work group 3 falls under FP2 with focus on fostering synergies among different streams of activities in order to support a sustainable process of scaling bundled CSA solutions (linking practices, technologies and services) through robust and actionable science, co-creation and capacity building underpinned by business models and sustainable finance using a gender lens.

Based on this, bundling of the CSA practices based on the end-user needs and commodity value chains was undertaken in respect of the top five prioritized CSA practices for each commodities. The budling process also took into account, the complementary nature of the CSA practices in the

proposed intervention communities. Tables 5-8 below presence the AICCRA-Ghana Regional CSA Practice Bundles for aize, cowpea, yam, potato and tomatoes for the various intervention areas.

Table 5: Bono East CSA Bundles for Maize, Cowpea & Yam

No.	District/ Communities	Specific Commodity	Proposed Bundled CSA Practices	Basic components of technology packages	Start Time (month)
Bundle 1	Kintampo North (Adomano & Bawakura)	Yam	Biological soil and seed treatment (Application of neem leaf powder to treat soil and ash to treat seed yam before planting	Seed Yam, neem powder and wood ash	Feb
			Seedbed options-Ridging as an alternative to mounding for yam production	Mechanised ridgers	
			Staking Options-Trellis/Minimum staking to reduce deforestation in yam production	Thick jute ropes; stacks (bamboo, twigs or metal)	
			Promotion of Seed yam multiplication technologies (mini-sett technology; aeroponics and hydroponics technologies)	Mini-setts, aeroponic or hydroponic -generated seed yam and farmer-saved seed yam	
Bundle 2	Kintampo South (Adiemra & Agyegyemakunu) Techiman North (Offuman & Droboagya)	Maize, Cowpea	Minimum tillage for maize and cowpea production	Planters/dibblers, herbicide, slasher	March
			Promotion of stress (drought, early maturing, striga and low N) tolerant Improved maize, cowpea varieties	Multi-stressed (drought, early maturing, low N) improved maize seed	
			Promotion of disease and pest tolerant maize and cowpea varieties	Disease and pest tolerant maize and cowpea varieties	
			Enhanced biopesticide use in maize and cowpea systems	Neem, wood ash, …….	
Cross Cutting Issues		Maize, Cowpea, Yam	Organic amendment for improving soil health / Leguminous crops as previous crop	Farm yard manure, bagged compost, Leguminous seeds	All year round
			Enhancing access to climate information	Seasonal calendar ……	

Table 6: Central Region CSA Bundles for Sweet Potato

No.	District/ Communities	Specific Commodity	Proposed Bundled CSA Practices	Basic components of technology packages	Start Time (month)
Bundle 1	Cape Coast Metropolitan (Amamoma & Effutu Koforidua) Elmina Municipality (Dominase & Ayinase)	Sweet Potato	Vine technology (cutting and planting)	Pest-free vines 1st Gen: aeroponics and hydroponics generated vines 2nd Gen: cuttings from certified seed farms	March
			Promotion of vine multiplication technologies (aeroponics and hydroponics technologies)		
			Biocontrol of the sweet potato beetle	Pheromones, traps, Entomo-pathogens (Bb), companion cropping	
Cross Cutting Issue			Organic amendment for improving soil health / Leguminous crops as previous crop	Farm yard manure, bagged compost; leguminous seed	All year round
			Enhancing access to climate information	Seasonal calendar ……	All year round

Table 7: Northern Region CSA Bundles for Maize, Cowpea & Yam

No.	District/ Communities	Specific Commodity	Proposed Bundled CSA Practices	Basic components of technology packages	Start Time (month)
Bundle 1	Tolon (Nyankpala. Woribogu & Yizeigu)	Maize, Cowpea, Sweet Potato	Minimum tillage for maize, cowpea and vegetable production	Planters/dibblers, herbicide, slasher	March
			Promotion of stress (drought, early maturing, striga and low N) tolerant Improved maize, cowpea varieties	Multi-stressed (drought, early maturing, low N striga) improved maize seed	
			Promotion of disease and pest tolerant maize, cowpea, potato and yam varieties	Disease and pest tolerant maize and cowpea varieties	
			Enhanced biopesticide use in maize and cowpea systems	Neem, wood ash, …….	
Bundle 2		Yam	Biological soil and seed treatment (Application of neem leaf powder to treat soil and ash to treat seed yam before planting	Seed Yam, neem powder and wood ash	Feb
			Seedbed options-Ridging as an alternative to mounding for yam production	Mechanised ridgers	
			Staking Options-Trellis/Minimum staking to reduce deforestation in yam production -	Thick jute ropes; stacks (bamboo, twigs or metal)	
			Promotion of Seed yam multiplication technologies (mini-sett technology; aeroponics and hydroponics technologies)	Mini-setts, aeroponic or hydroponic - generated seed yam and farmer-saved seed yam	
Bundle 3		Maize, Cowpea, Yam	Mucuna pruriens or cowpea /maize intercropping-yam rotation to build soil C stocks	Mucuna, cowpea and maize seeds	May
			Promotion of dual-purpose cowpea (grain and fodder)	Dual purpose cowpea varieties	
Cross Cutting Issues			Organic amendment for improving soil health / Leguminous crops as previous crop	Farm yard manure, bagged compost; leguminous seed	All year round
			Enhancing access to climate information	Seasonal calendar ……	

Table 8: Upper West & Upper East Regional CSA Bundles for Maize, Cowpea & Tomato

No.	District/ Commodities	Specific Commodity	Proposed Bundled CSA Practices	Basic components of technology packages	Start Time (month)
Bundle 1	Lawra (Boompari & Dzuuri) Jirapa (Doggoh)	Maize, Cowpea,	Mucuna pruriens or cowpea /maize intercropping to build soil C stocks	Mucuna or cowpea seeds	May
			Contour stone bunds or contour tillage with tied ridges (Zero or minimal rates of rainfall run-off and soil erosion)		
			Promotion of dual-purpose cowpea (grain and fodder)	Dual purpose cowpea varieties	May
Bundle 2		Maize, Cowpea,	Minimum tillage for maize, cowpea and vegetable production	Planters/dibblers, herbicide, slasher	May
			Promotion of disease and pest tolerant maize & cowpea varieties	Disease and pest tolerant maize and cowpea varieties	
			Enhanced biopesticide use in maize and cowpea systems	Neem, wood ash, …….	
Bundle 3	Navrongo (Tampola)	Tomatoes	Contour stone bunds or contour tillage with tied ridges (Zero or minimal rates of rainfall run-off and soil erosion)		
			Promotion of drip and sprinkler irrigation for vegetable farming		
Cross Cutting Issues			Organic amendment for improving soil health / Leguminous crops as previous crop	Farm yard manure, bagged compost; leguminous seed	All year round
			Enhancing access to climate information	Seasonal calendar ……	

Conclusion

The prioritization process formed a major step towards a successful impplemetation of the AICCRA-Ghana project. This process was participatory with the inovlement of farmers, scientist, extension agents, private sector operators, researchers and development workers in the implementing regions. It is eveident from the prioritization and bundling processes that improved seed, soil fertility improvement and water management (small scale irrigation) are invariable the products for sustainable financing in the intervention areas. The process further took in to considerable recognition of gender in term of women and youth involvement in the uptake and utilization of the of the prioritized CSA practices. AICCRA-Ghana's careful

analysis of the CSA practices to demonstrate to farmers in the various intervention areas was identified as remarkable achievement among other AICCRA intervention countries although its a continuous process.

This process of CSA identification and prioritization also sets the stage for the first step of scaling up processes through farm demonstrations, media engagements as well as end-user capacity development.

To sustain the gains of AICCRA-Ghana, the next step of the sustainable financing is to identified private entities and service providers to match end-user needs to private investors in the various intervention communities.

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