TITLE:

Building the Resilience of Smallholder Farmers to Climate-Induced Pests and Diseases Through Promotion of CS-IPM Innovations

ACTIVITY REPORT

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October 2024

To cite this report

[Adomako, A. et al., (2024). **Building the Resilience of Smallholder Farmers to Climate-Induced Pests and Diseases Through Promotion of CS-IPM Innovations.** Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA), AICCRA Technical Report.

Acknowledgments

Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) is a project that helps deliver a climate-smart African future driven by science and innovation in agriculture. It is led by the Alliance of Bioversity International and CIAT and supported by a grant from the International Development Association (IDA) of the World Bank.

The authors would like to thank our farmers and staff of the Department of Agriculture at various intervention districts.

About AICCRA Reports

Titles in this series aim to disseminate interim research on the scaling of climate services and climate-smart agriculture in Africa, to stimulate feedback from the scientific community.

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About AICCRA

AICCRA

Accelerating the Impact of CGIAR Climate Research for Africa

Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) is a project that helps deliver a climate-smart African future driven by science and innovation in agriculture. It is led by the Alliance of Bioversity International and CIAT and supported by a grant from the International Development Associatior (IDA) of the World Bank. Explore our work at **aiccra.cgiar.org**

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ABBREVIATIONS

AICCRA	Accelerating Impacts of CGIAR Climate Research in Africa
ABC	Alliance Bioversity International and CIAT
CGIAR	Consultative Group of International Agricultural Research Centres
FFS	Farmer Field School
CIS	Climate Information Services
CSA	Climate Smart Agriculture
CSIR	Council for Scientific and Industrial Research
FP	Farmer Practice
MMDDoA	Metropolitan/Municipal/District Department of Agriculture
MoFA	Ministry of Food and Agriculture
UDS	University for Development Studies

1.0 INTRODUCTION

Generally, synthetic chemicals are used in seed and soil treatments to provide protection against pathogens, improve soil conditions, and increase crop productivity. However, a consistent call for the reduction and in some cases total elimination of the use of synthetic fertilizers and pesticides in crop production is being championed to maintain the ecosystem and improve sustainable agriculture. This demand has become insistent due to the negative effect synthetic pesticides present on the environment and their contribution to climate change effect. An alternative approach is to rely on the application of natural antagonists capable of stimulating natural resistance responses by the host plant. Again, continuous yam production leads to massive soil nutrient depletion, yet less effort is put in place to restore soil fertility. This forces farmers to migrate annually in search of fertile lands leading to the clearing of new land thereby contributing to the climate change effect due to the depletion of forest reserves. For farmers who replant their fields, limited knowledge in restoring soil fertility affects the productivity of the yam crop leading to reduced yields, income and increased vulnerability. Therefore, it is necessary to provide strategies to improve the sustainability of yam production.

1.1 Co-Application of *Trichoderma asperellum* powder and Compost as validated CS-IPM and Soil Fertility improvement innovation for sustainable yam production

To sustainably manage pests and diseases as well as improve soil health/fertility for yam production, AICCRA promoted the use of *Trichoderma asperellum* powder and compost as an integrated approach to address the effects of pests and diseases and declining soil fertility. Currently, beneficial microorganisms like Trichoderma species are progressively being promoted and used as inoculants for biofertilization and biocontrol (Kumar et al., 2022; Mukherjee et al., 2022; Appiah-Kubi et al. 2018). Generally applied to improve photosynthetic efficiency, enhance nutrient uptake and increase nitrogen use efficiency in crops. Specifically, when applied as a seed treatment, Trichoderma inoculant helps improve the growth of crops, nutrition and water intake, increases seedling vigour, and establishes systemic resistance to biotic and abiotic stressors. The application of composts provides nutrients and increases crop yield by improving the soil's physical, chemical, and biological properties such as soil aeration, water infiltration and plant root penetration. In addition to their direct benefits, compost provides a food source for Trichoderma to utilize and accelerate the decomposition of organic matter, solubilization of insoluble minerals and capturing of nutrients for increased crop growth performance and yield improvement. Combining composts with beneficial microorganisms has proven to increase crop production and reduce plant diseases (Zhang et al. 2013). Trichoderma-enriched compost has been used to maintain a stable crop yield with reduced use of chemical fertilizers, due to their effect on improving soil microbiota and soil nutrient availability. The disease suppressiveness of composts and Trichoderma co-application is due not only to its biocontrol ability but also to the changes it induces in both abiotic and biotic soil characteristics. To increase the resilience of farmers to climate-induced biotic-abiotic stress, there is a need to introduce them to sustainable innovations through capacitation and increasing access to the innovations. Community CSA hubs were established to showcase the integrated use of Trichoderma powder, compost and neem seed cake/ neem leaf powder in yam production to effectively manage soil-borne pathogens, improve soil conditions, and increase yam productivity. Similarly, to increase the productivity of nutrient-rich sweet potato varieties to curb household food insecurity and malnutrition, integrated pest management with biopesticides and onion intercropping was undertaken to reduce the impact of sweet potato weevil and other soil arthropod pests that damage sweet potato roots and reduce their marketability. The neem powder plays a dual role of improving soil organic matter also as a biopesticide.

2.0 STUDY FOCUS

Yam and Sweetpotato are important value chains in Ghana's Bono East and Central regions. Issues of climate variability, pests, and disease continue to affect the productivity of the crops and deny farmers the desired yield and benefit. Promoting validated CSA innovations has the potential to increase resilience and improve the livelihood of vulnerable farmers to the negative effects of climate change. To enhance the adoption of climate-smart innovations, CSA hubs were established across 25 communities in three districts in Bono East (Techiman North, Kintampo North, and

Kintampo South) and 2 districts in the central region (Cape Coast and KEEA) where unpredicted environmental conditions are affecting crop production. To promote ownership of the innovation hubs, facilitate access to innovations and promote farmer-to-farmer transfer of knowledge, CSA farmer platforms consisting of mainly of farmers, and other stakeholders like marketers, AEA Officers and opinion leaders in the community to manager the community hubs. The innovations being promoted are aimed at helping farmers improve soil moisture conservation, reduce the abuse and negative consequences of inorganic pesticides, increase soil microflora diversity for improved soil health, improve yield, and subsequently increase the income of farmers. Specifically, the use of Trichoderma powder and the application of compost as new validated CSA technologies were introduced to yam farmers for use as biofertilizers and biopesticides to improve soil conditions and protect seed and soil-borne pathogens. Also, different sweet potato varieties plus the use of neem leaf powder and onion as a border were introduced as new validated CSA technologies.

3.0 APPROACH

3.1 Co-established CSA/One Health community Hubs for yam and sweetpotato

Six community CSA hubs were established across three AICCRA intervention districts in Bono East regions using the participatory learning approach involving farmers, intermediaries, and knowledge generators (Appendix 5, Appendix 6). At each hub, the use of Trichoderma powder to treat yam minisetts as an alternative to synthetic pesticides, the application of compost as a soil amendment on ridges, neem seed cake application, and the use of trellis as a staking option were demonstrated. To help farmers properly evaluate the technologies being deployed, for each of the community hubs, the community selected and compared AICCRA innovations with their conventional/traditional means of farming (farmer practices, (FP)) in each locality.

Table 1. The yam innovations being showcased

Value Chain	CSA/One Health Innovations Promoted	Communities
Yam	**CSA-Soil fertility improvement/One Health Innovation**: Incorporation of compost during ridging for soil fertility improvement + Yam seed treatment with Trichoderma powder+ Soil amendment with neem seed cake + Ridges as an alternative to mounding+ Use of Trellis for staking	Asueye, Atrensu, Techira No1, Kobeda, Kwabia, Yamoakrom

Five demonstration plots were established in four new CSA communities and one old community to introduce and train farmers on Neem leaf powder and onion intercrop to manage the Sweet Potato weevil (*Cylas sp*.) in sweet potato production (Table 2). This is to limit the rampant use of pesticides in mitigating the damage associated with sweet potato weevil infestations and ensure the sustainable production of clean marketable sweet potatoes for consumption. As part of the Orange Flesh Sweet Potato (OFSP) already being promoted by the AICCRA project, an additional variety known as the Purple Flesh Sweet Potato (PFSP) was introduced this year. The communities selected were Akotokyir and Efutu in the Cape Coast Metropolitan Assembly and Dompoase, Ankaful and Saaman in the KEEA Municipality.

Table 2. The sweet potato innovations being showcased

Value Chain	CSA/One Health Innovations Promoted	Communities
Sweet potato	Neem leaf powder as a soil amendment and biopesticide, onion intercrop, planting pests and disease-free vines, Orange-flesh variety, Purple-flesh variety and planting on ridges	Akotokyir, Efutu , Dompoase, Ankaful and Saaman

3.2 Knowledge of *Trichoderma* and compost as biofertilizers and biopesticides enhanced

Three hundred and seventy participants consisting of 350 CSA farmers, and twenty Agricultural Extension Agents were directly trained through CSA meetings and workshops on the benefits, handling and application of both Trichoderma powder and compost in yam production. Again, facilitators help farmers appreciate soil health and various soil health management practices. Of the total number of farmer beneficiaries, 140 (40.0%) and 210 (60.0%) were female and male respectively. Again, 65.0% of the participants were youth below the age of 35 years. The training introduced participants to the concept of one health, integrated pest management, biological control agents, and compost application. The discussions enabled farmers to appreciate sustainable means of restoring the fertility of their soil and protecting their crops from soilborne pathogens without using synthetic inputs or migrating for new arable lands. Knowledge of farmers was increased as all (100%) confessed that it was their first time seeing and hearing about Trichoderma powder and its use in yam production. Similarly, the majority (85.0%) of participants indicated that incorporating compost into soil for yam production was an innovation they had not observed before. Following the excitement of the farmers to utilise the acquired knowledge, participants received information. They were connected to input dealers such as Demeter Ghana, ACARP and Widows and Orphans Movement (WOM) in the Upper East Region involved in marketing Trichoderma powder, compost and neem seed cake respectively.

3.3 Increased Access to CSA-One Health Innovations through Community Outreach Days

Eighteen community outreach days directly engaging 850 yam farmers were organized across the six communities during the land preparation, planting, and harvesting stages of yam. Five-hundred and twenty-seven (62.0%) and 323 (38.0%) of the yam farmers engaged were males and females respectively (Fig 1). Fifty-nine percent and 41.0% of the participants were above and below the age of 35. Farmers were introduced and participated in the construction and incorporation of compost on ridges during the land preparation stage. At planting, farmers were involved in the preparation of yam minisetts, treating minisetts with Trichoderma powder, and soil amendment with neem seed cake (Appendix 5, 6, 7, 9). Field sanitation and proper staking are crucial activities in yam production so field days were organized at various times to ensure good field maintenance. For each of the field outreach days, participants present had the opportunity to compare, the CSA/One Health innovation being promoted and the conventional/traditional practice used by the community. Again, they had the opportunity to interact with the knowledge generators and other stakeholders to enhance their knowledge and understanding of the technology (Appendix 8). To also increase access to the technology, samples of the Trichoderma, compost and neem seed cakes were showcased on each field day.

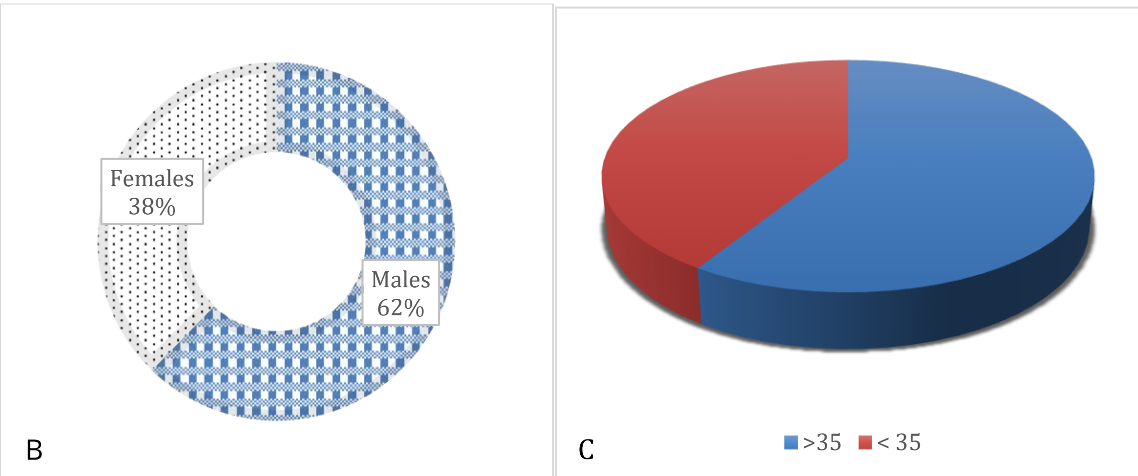


Fig.1 B-C: Sex and age distribution of participants at Yam community outreach activities

Five demonstration trials were established to showcase the management of sweet potato weevil in five communities while the five old communities were provided with seeds to continue the project. A total of 1,760 farmers (840 males: 920 females) have been trained in the CS-IPM strategy for managing Cylas species (Figure 2).

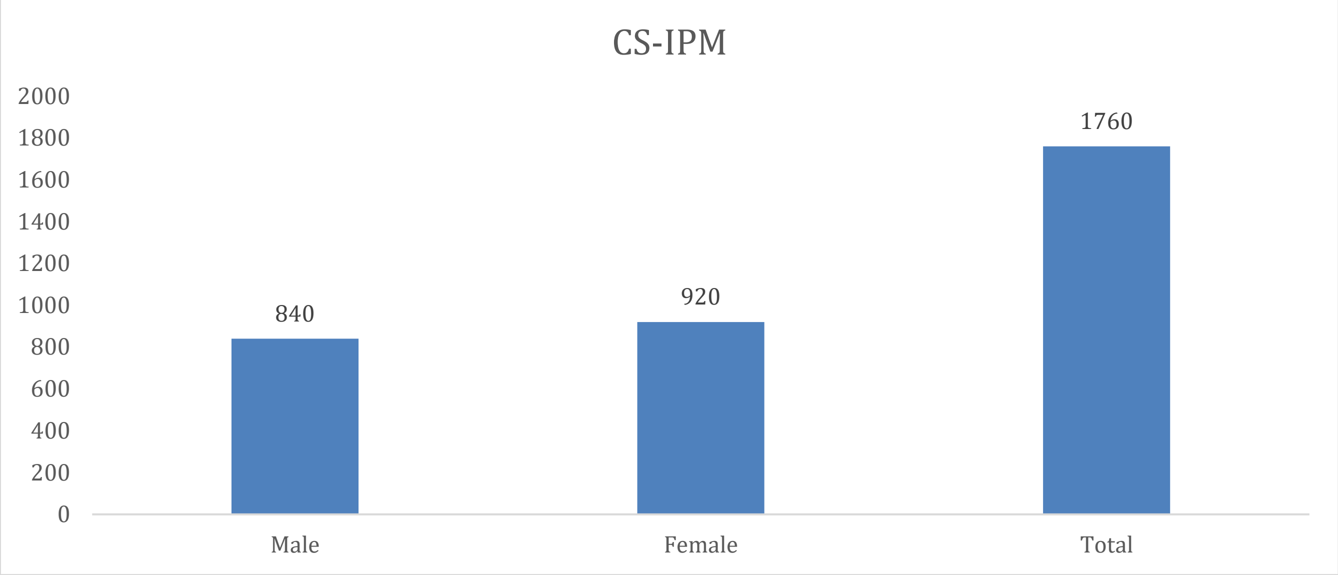


Fig 2: Farmers reached with CS-IPM innovations

3.4 Application of CS-IPM Innovations Increases Seed Vigour and Seedling Establishment

Combined applications of *Trichoderma* powder for miniset treatment, incorporation of compost, and soil amendment with neem seed increased yam minisett germination and seedling establishment. More (900) yam sets were planted on AICCRA CSA/OneHealth plots across the locations than the farmer practice plots (560) (Fig.3). Specifically, 38.0% more setts were planted on the ridges than the mounds on equal land size used. Again, more yam setts germinated and established uniformly on the CSA/OneHealth plots compared to the farmer practice. Although a long dry spell was experienced after planting, more (75.0%) of yam seeds from AICCRA innovation plots germinated compared to 50.0% from farmer practice plots (Fig.3). This observation agrees with Xue et al. (2017) that application of *Trichoderma* improves seed vigor and germination. Similarly, the application of compost improves soil health which favours seed germination and seedling establishment. Tuber yields were also higher.

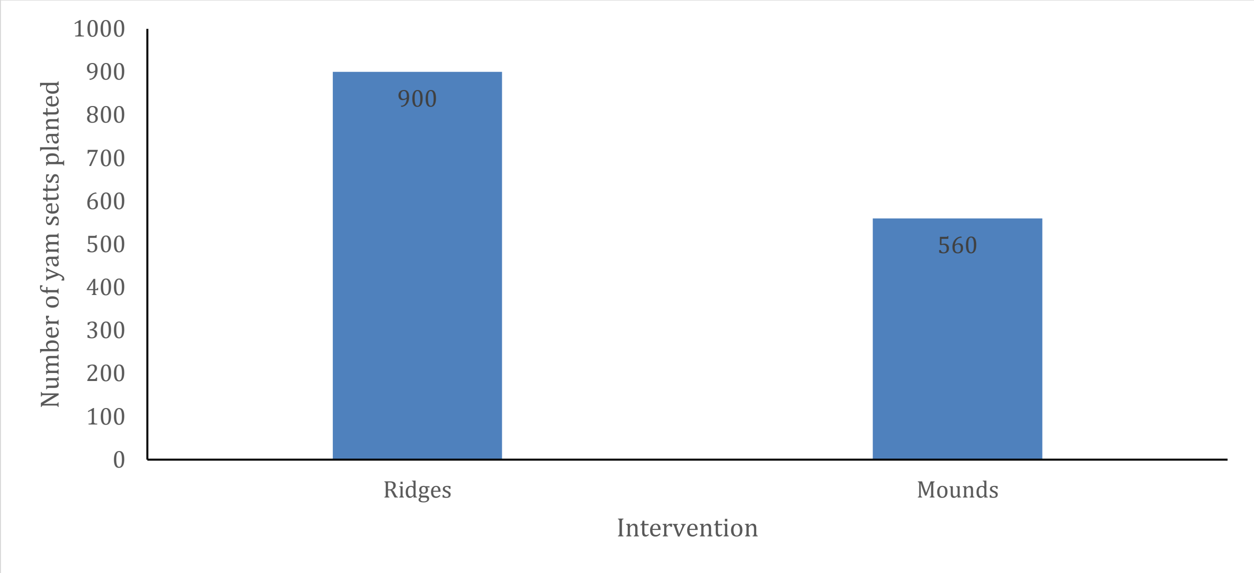


Fig. 3. Yam seeding population for various land forms

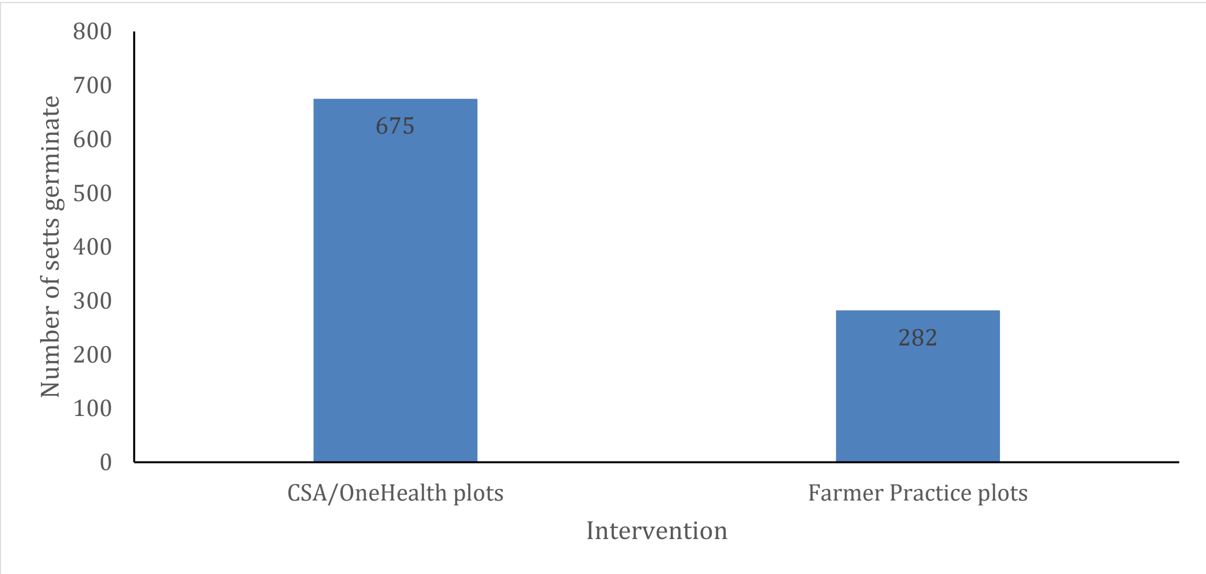


Fig. 4. Number of germinated setts from the various plots

The Neem and onion treatment plots didn't show any visible signs of *Cylas* sp. infestation on the basal portions of the vines, as compared to farmer practice plots (Plate A)

3.5 AICCRA intervention impact positively on yield, tuber health and income of farmers

Across all the six community CSA hubs, it was observed that higher tuber yields were obtained from AICCRA CS-IPM fields/plots compared to traditional farmer practice fields. On average, 25% more tubers were harvested from AICCRA innovation plots than the farmer practice plots. This confirms Bergh et al. (2012) that growing yams on ridges outyield yams grown on mounds. Significantly, AICCRA intervention reduced the number of harvested yam tubers with symptoms of soil-borne pathogens and arthropod pest damage. Of the 960 tubers harvested from farmer practice plots across the six locations, 242 (30.0%) tubers showed symptoms of tuber galling, tuber cracking and holes. However, from the same locations, 116 (10.0%) tubers out of the 1,160 tubers harvested from AICCRA innovation plots presented similar symptoms (Fig.4). This means 90 out of every 100 yam tubers harvested, from the AICCRA innovation fields were marketable while 30% of tubers harvested from farmer practice fields were discarded. This trend can greatly affect marketing or storage contributing to food insecurity and depriving farmers of their income. Translating obtained yam yield to income, at a price of USD2.56/tuber (https://3news.com, June 20, 2024), using AICCRA intervention can increase farmers' income by USD512.0 more than conventional practices.

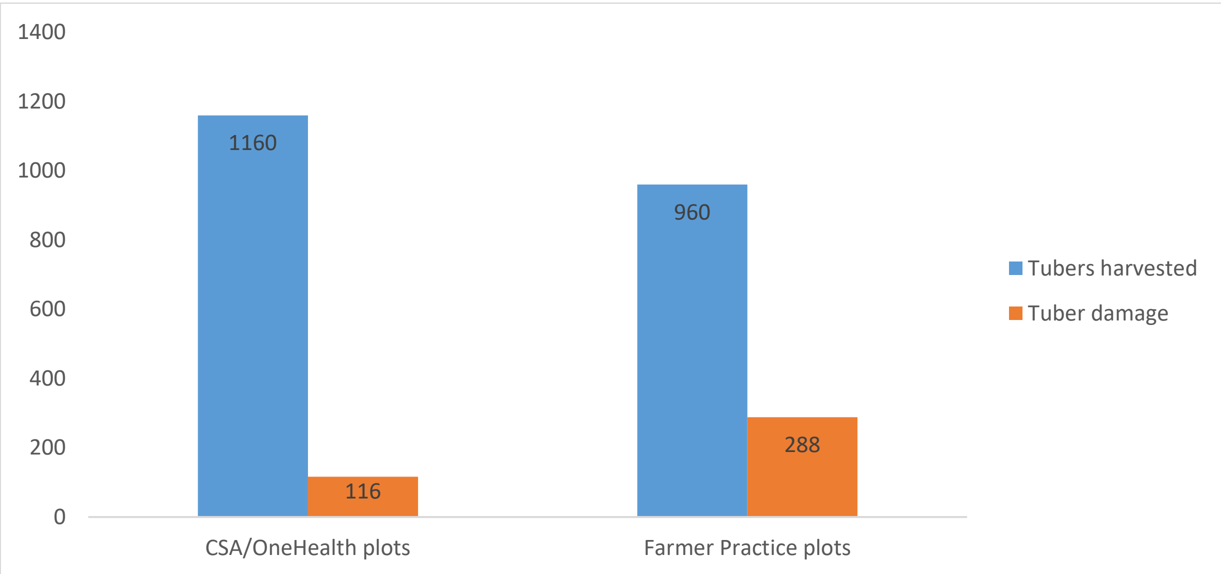


Fig 4. Total tubers harvested and number of tubers with pest damage symptoms


Plate 1: Weighing and evaluating yam tubers after harvest

Regarding the sweet potato demonstration, figure 5 shows that the neem and onion treatments performed better in terms of mean root weight which is key where marketability is concerned. Neem-treated plots recorded higher mean root weight followed by onion border/intercrop plots. The tubers harvested were clean, sizeable and devoid of soil arthropod damage (Appendix Plate 2). Although the farmer practice plots recorded more tubers, they were small and unmarketable with root damage (visible cracks and arthropod feeding holes and tunnels). This contributed to the comparatively low root weight recorded on farmer practice plots, thereby convincing farmers of the efficacy of the IPM technology made accessible to them. The tubers harvested were clean sizeable and devoid of soil arthropod damage (Appendix Plate 1). Although the farmer practice plots recorded more tubers, they were unmarketable with root damage (visible cracks and arthropod feeding holes and tunnels). This contributed to the comparatively low root weight recorded on farmer practice plots, thereby convincing farmers of the efficacy of the IPM technology made accessible to them.

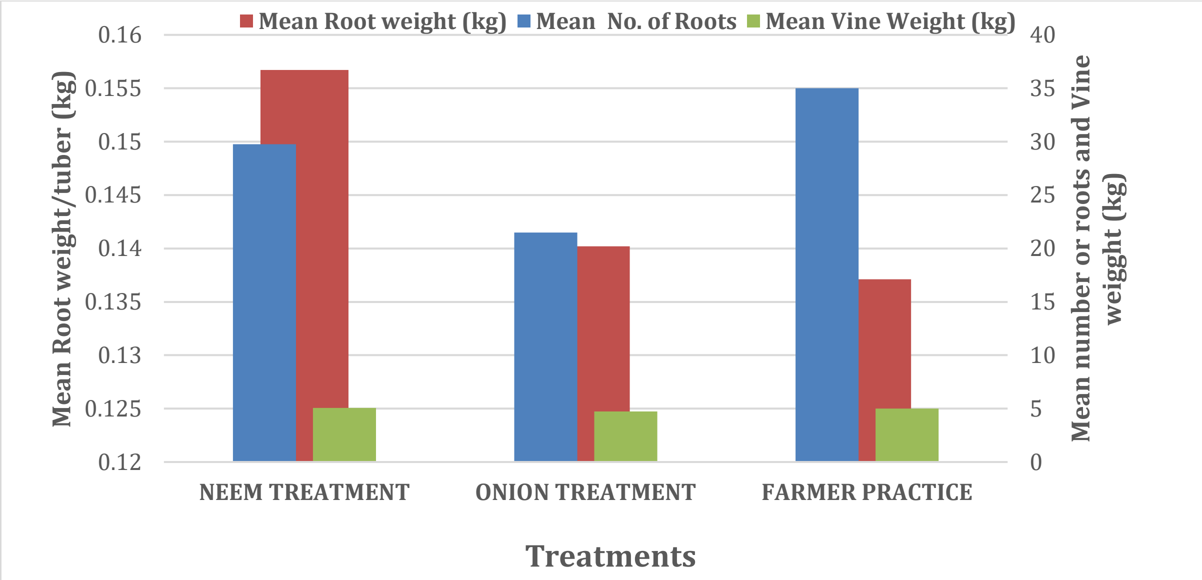
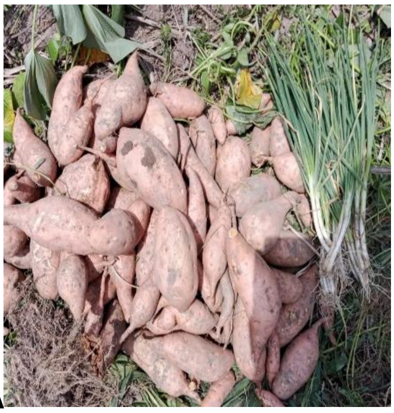


Fig 5. The effect of IPM strategies on sweet potato roots and vine yield, compared to Farmer Practice

A  B 

C 

Plate 2: Harvested OFSP (CRI-Apomuden) from A) Onion Intercrop, B) neem-treated plots and C) Farmer practice plots

3.6 Evidence of Farmer Engagements

1. **https://www.graphic.com.gh/news/general-news/central-region-54-farmers-equipped-with-climate-resilient-farming-technology.html** A publication in the Daily graphic covering the Farmers Field Day help at Akotokyir (new CSA-HUB) in Cape Coast. Farmers expressed the benefit of the CSA training to improving farm productivity. They requested such support to help overcome the challenges of climate change.

2. **https://www.youtube.com/watch?v=lPwc4VTnbfo** A cover story by Adom News during Farmers Field Day held at Saaman (new CSA-HUB) in KEEA. The producers were excited with the performance of the technologies despite the long dry spell and the associated heat observed over the season.

3. **https://drive.google.com/file/d/1Q97hgXvWaN1Ar2PVTigVDaUT-dCyL0LR/view?usp=drive_link** Farmer's response to Climate Smart Agricultural technologies during training and capacity building exercise at Saaman in KEEA. The farmers requested support to access and use the technologies showcased for sweet potato production.

4. **https://drive.google.com/file/d/1dybJ0LTko_Mb0Y6sTf2mKfmRUzg5EhnP/view?usp=drive_link** AEA and farmers interact after CSA Capacity Building. The extension officers encourage the beneficiary farmers to serve as anchor farmers so that other farmers can learn from them.

5. **https://drive.google.com/file/d/16zGySOgYMOs_Y23LUGFWtp0Dx0Bey9Eb/view?usp=drive_link** CSA Farmers participating in the planting of yam on ridges.

6. https://drive.google.com/file/d/1ExthRxKQHxbXTr91c9r7zuUqFTRZuqg3/view?usp=sharing Female yam farmers treating yam minisetts with Trichoderma asperellum solution.

7. https://drive.google.com/file/d/1BKGfH7z00-y8xGO9N9-EpjXuLL9mvuMp/view?usp=sharing

8. **https://drive.google.com/file/d/1oHjugaIxKU715fnYow0FSewywF0Nox_F/view?usp=drive_link** CSIR-CRI Technician engaging and explaining to both female and male yam farmers on the relevance of the innovation being promoted.

9. **https://drive.google.com/file/d/12Bx3QBPRGIdDuKikmYlB5LjLkTyA-ReQ/view?usp=drive_link** Female yam CSA farmers participating in land preparation for field establishment

3.7 Key Challenges

1. Delayed planting due to changes in weather patterns (delayed rains and frequent dry spells)
2. Farmer's reluctance to cultivate OFSP variety due to consumer preference for local varieties.
3. Farmer's preference for target market before planting some varieties, especially the Orange Flesh Sweet Potato variety.

3.8 Way forward

1. Include private market partnerships in sweet potato CSA bundles to incentivise the producers
2. Educate consumers on the nutritional benefits of available sweet potato varieties as a food security crop
3. Strengthened value addition (Processing) to the sweet potato value chain.
4. Intensify farmer's education on the adoption of biopesticides as an alternative to synthetic pesticides for sustainable agriculture

3.9 Lessons Learned

1. Farmers appreciated evidence-based learning.
2. Farmers were willing to adopt management strategies that were cost-effective and not labor-intensive.

9.0 CONCLUSION

Six community CSA hubs were established in three new AICCRA intervention districts in Bono East regions using the participatory learning approach to showcase the use of Trichoderma powder to treat yam minisetts as an alternative to synthetic pesticides, application of compost as a soil amendment on ridges and neem seed cake for yam production. With regards to sweet potato, five community CSA hubs were established in Central region to showcase different orange-fleshed sweet potato varieties and the use of neem powder and onion as a border crop to reduce infestation of sweetpotato weevil. Eighteen community outreach days directly engaging 850 yam farmers were organized across the six CSA hubs working of yam during the land preparation, planting and harvesting stages of yam. Five-hundred and twenty-seven (62.0%) and 323 (38.0%) were male and female respectively. A total of 1,760 farmers (840 males: 920 females) were reached directly with the sweetpotato technologies. Across all the eleven community CSA hubs, it was observed that the adoption of AICCRA CSA/OneHealth innovations resulted in higher tuber and root yield compared to traditional farming practices

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