Artificial Intelligence for Agriculture and Food Systems (AI4AFS) Innovation Research Network Project Implementation Brief

Supporting the responsible development, deployment, and scale of artificial intelligence applications and tools that ensure gender equality and social inclusion in Africa's Agriculture and Food Systems.

Funded by

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ARTIFICIAL INTELLIGENCE FOR DEVELOPMENT AFRICA

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Artificial Intelligence for Agriculture and Food Systems (AI4AFS) Innovation Research Network Project Implementation

PARTNERS

AFRICAN TECHNOLOGY POLICY STUDIES NETWORK

icipe

KUMASI HIVE

Contents

MESSAGES FROM KEY PLAYERS 7

ABOUT THE DONORS 14

ABOUT THE AI4AFS PARTNER ORGANIZATIONS 16

PART A: ARTIFICIAL INTELLIGENCE FOR AGRICULTURE AND FOOD SYSTEMS' PROJECT OVERVIEW AND GRANTEES' SELECTION PROCESSES 19

PART B: PRESENTATION OF THE 10 FUNDED AI4AFS PROJECTS 32

MESSAGES FROM KEY PLAYERS

MESSAGE FROM THE PRINCIPAL INVESTIGATOR

Dr Nicholas Ozor
Executive Director, ATPS
Principal Investigator, AI4AFS

The African Technology Policy Studies Network (ATPS) and its partners, icipe and Kumasi Hive are very pleased to present an overview of our journey, status, and milestone so far as a *Managing Organization (Hub) for Responsible Artificial Intelligence for Agriculture and Food Systems Innovation Research Network in Africa (AI4AFS).* This project is part of the innovation stream of the Artificial Intelligence for Development Africa (AI4D Africa) program dedicated to a future where Africans across all regions create and use artificial intelligence to lead healthier, happier, and greener lives. The project is predicated on the need to provide food, feed, fibre, and fun to over 1.3 billion African population that is estimated to reach 2.6 billion by 2050. Achieving sustainable and adequate food supply to meet the demands of this teeming population requires the adoption of emerging technologies and the responsible artificial intelligence technologies stand out among many to accomplish this daunting task.

The AI4AFS aims to advance the responsible development, deployment, and scaling of homegrown AI research and innovations to tackle pressing challenges in agriculture and food systems in Africa. In the last 20 months of inception of this project, the AI4AFS Hub has effectively set-up, managed, and supported ten (10) innovation research network projects on AI for agriculture and food systems drawn from eight African countries to develop, deploy, test, and seek to scale responsible and homegrown artificial intelligence research and innovations. Careful considerations have been made to ensure that the 10 selected innovation research projects were drawn from the Anglophone, Francophone, and Lusophone countries of sub-Saharan Africa with equal distribution across gender and collaborations among research, private sector, and civil society organizations/ Think Tanks that make our AI4AFS network Hub

a unique one. This structure is already paying off in terms of deepening the understanding of the network on how to develop, deploy, and scale responsible AI innovations for sustainable AFS in Africa as well as in the use of lessons learned to inform African and international AI policy and practice conversations. The AI4AFS network projects as presented in this brochure are at different levels of project implementation and we are happy to report that they are all on course according to their work plans.

Finally, as the Principal Investigator of the AI4AFS Innovation research network Hub, I am happy to report that we have presented many papers in different international fora on AI in agriculture and food systems, served as Panelists on the subject matter, and published a Working Paper on *"Responsible Artificial Intelligence for Africa's Agriculture and Food Systems: Challenges and Opportunities".* This paper can be accessed on the ATPS AI4AFS project website at: https://atpsnet.org/ai4afs-hub/. I want to appreciate my team from the ATPS and our partners at icipe and Kumasi Hive for their full dedication and commitment to this project. Most importantly, I want to thank the IDRC and Sida for their initiative to fund the AI4D Africa Program and particularly the AI4AFS project. We commit to ensuring high impact and value for money in our AI4AFS innovation research Hub and projects even as we look forward to the continued partnership and support to this laudable initiative, the first of its kind and scale in Africa.

MESSAGE FROM THE CO-PRINCIPAL INVESTIGATOR

Dr. Henri Tonnang
Co-PI , icipe & Head, DMMG

As a partner in the AI4AFS hub, *icipe* has worked with ATPS and Kumasi hive from the start of the project in September 2021, and now working with grantees on high-quality AI research projects that are currently at development and/or deployment stage in eight countries in Africa. The Hub has ensured that such AI tools are developed responsibly and designed with inclusion of the vulnerable and marginalised farmers so that such groups are not excluded from AI-related benefits.

The AI innovations range from tools for early detection and rapid diagnosis of diseases and pests, to tools that use data on remote sensing for prediction of crop yield, use of wireless sensor networks to monitor soil, weather conditions, irrigation water availability coupled with drones to monitor crop growth and smart irrigation systems and e-extension support and other tools. The compliance of our grantees to co-design of AI tools by inclusion is key as AI technologies might widen the gap between the vulnerable and the well to do/commercial farmers. For *icipe,* this project is being coordinated by the Data Management, Modelling, and Geo-Information (DMMG) Unit, a unit that leverages application of responsible artificial intelligence (AI) in Plant Health, Animal Health, Human Health, and Environmental Health, the 4Hs of *icipe's* research focus (http://www.icipe.org/research). The unit uses advanced methods and analytics including machine learning (ML), AI, design thinking, system thinking and system dynamics, and computer vision algorithms to exploit and interpret 'big data' to develop mobile apps and geospatial cloud-based tools that are operationally utilized for 'real time' surveillance, monitoring, and forecasting of insect pests, crop and environmental health indicators in the strife to achieve sustainable development goals.

MESSAGE FROM THE CO-PRINCIPAL INVESTIGATOR

Jorge Appiah
Co-PI & Executive Director, Kumasi Hive

Artificial Intelligence (AI) has the potential to revolutionize agriculture and food systems in Africa by improving crop yields, reducing food waste, and increasing efficiency throughout the supply chain. AI-powered technologies such as precision farming, predictive analytics, and automated decision-making systems can help farmers make more informed decisions about planting, harvesting, and managing their crops. In addition, it can be used to monitor soil quality, track weather patterns, and optimize irrigation, all of which can contribute to sustainable agriculture practices. However, some challenges must be addressed for AI to be effectively utilized in African agriculture and food systems. These challenges include limited access to technology and infrastructure, lack of data and digital literacy, and concerns about privacy and security.

The AI4AFS Hub together with the sub-grantees over the period have been innovating around to develop homegrown solutions using AI technologies. We acknowledge our potential as Africans to address food system challenges with the help of AI technologies. Overall, the potential benefits of AI for agriculture and food systems in Africa are significant, but careful attention must be paid to ensure that these technologies are implemented in an equitable, sustainable, and responsible manner.

MESSAGE FROM THE PROJECT MANAGER

Engr Dr. Joel Nwakaire
Project Manager, AI4AFS

The opportunity to coordinate such a wonderful project is a rare privilege, filled with lots of knowledge sharing and gaining. Working closely with programme management team to select ten innovative projects across eight sub-Saharan African countries was something of joy and highly tasking. As the Program Manager of the Responsible Artificial Intelligence for Agriculture and Food systems Innovation Research Network, my role involves overseeing the selection of network grantees through a rigorous process of call for expression of interest, call for full proposal, and selection of international expert reviewers. Additionally, I am responsible for conducting capacity training workshops, robust monitoring, and evaluation, and developing technical reports to be submitted to IDRC. We have made sure that all processes are transparent and ethically right. I am committed to ensuring the responsible development and deployment of AI applications in Africa's agriculture and food systems that is gender equitable and socially inclusive.I am committed to ensuring that the network achieves these objectives and delivers meaningful outcomes that contribute to improving the lives of African people while promoting responsible AI development and deployment. I am grateful to Dr. Nicholas Ozor for the privilege to serve in this capacity.

MESSAGE FROM THE IDRC PROJECT OFFICER

Gillian Dowie
IDRC Project Officer

The AI for Agriculture and Food Systems Innovation Research Network is an exceptional group of researchers that is making significant strides in utilizing AI to address some of the most pressing issues in Africa. The network is led by ATPS, Kumasi Hive, and Icipe, who have created a multidisciplinary and collaborative environment that fosters innovation and learning.

One of the standout features of this network is its commitment to supporting the next generation of African scientists and AI experts. By providing training and resources, the network is ensuring that there will be a sustainable pool of talent in the region to continue the work of developing innovative solutions.

The network is also highly committed to incorporating gender and inclusivity considerations in the design of solutions. This is a crucial aspect of responsible AI development, and it is encouraging to see the network actively working to ensure that the technology they develop is accessible and beneficial to all communities. The AI4AFS Innovation Research Network has the potential to showcase how AI can be used as a tool to support vulnerable people and communities. By designing technology that is accessible and relevant to those who need it most, the network is contributing to making AI an accessible technology instead of a barrier.

Finally, the network's commitment to collaboration is exemplary. In the fast-paced world of AI research, sharing knowledge and resources is essential to achieving meaningful progress. By working together, the network is advancing the field and developing solutions that have the potential to transform agriculture and food systems across Africa. It is a privilege to work with this group of researchers and innovators, and I look forward to seeing the exciting developments that emerge from this group in the future.

ABOUT THE DONORS

The International Development Research Centre (IDRC) is a Canadian federal corporation that supports research to find innovative solutions to some of the most pressing global challenges, including poverty, inequality, and climate change. In its effort to support Africa's development, the IDRC launched the Artificial Intelligence for Development (AI4D) initiative, a pan-African program aimed at harnessing the potential of AI for sustainable development.

Through AI4D, the IDRC provides funding and technical support for research projects that use AI to address development challenges in Africa. The program focuses on building AI capacity in African countries and promoting gender and social inclusion in AI research and applications. The AI4D African Program brings together a network of African AI researchers, policymakers, and practitioners, enabling them to collaborate and share knowledge to advance the use of AI for development on the continent.

The IDRC's support for the AI4D African Program demonstrates its commitment to promoting inclusive and sustainable development through innovation and research. Website: https://www.idrc.ca/

The Swedish International Development Cooperation Agency (Sida) is a government agency that provides support for sustainable development initiatives in low - and middle - income countries. One of the key areas of focus for Sida is promoting the use of technology and innovation to address development challenges. In line with this, Sida has provided significant support to the AI4D African Program, which aims to harness the power of artificial intelligence (AI) to drive socio-economic development across the African continent.

The AI4D African Program is a collaboration between various African governments, the African Institute for Mathematical Sciences (AIMS), and the International Development Research Centre (IDRC). The program aims to build capacity in AI research and development across the continent, promote the use of AI to address social and economic challenges, and facilitate collaboration between researchers, policymakers, and other stakeholders. Sida has provided funding to support the program's activities, which include providing research grants to African researchers working on AI-related projects, organizing training workshops and hackathons to build capacity in AI, and supporting policy dialogues and stakeholder engagement activities to ensure that the use of AI is aligned with local needs and priorities.

Through its support for the AI4D African Program, Sida is playing a key role in promoting the use of technology and innovation to address development challenges in Africa. By building local capacity in AI research and development, the program is helping to ensure that African countries can fully participate in the global AI revolution and leverage the potential of AI to drive socio-economic development and improve the lives of people across the continent. Website: https://www.sida.se/

ABOUT THE AI4AFS PARTNER ORGANIZATIONS

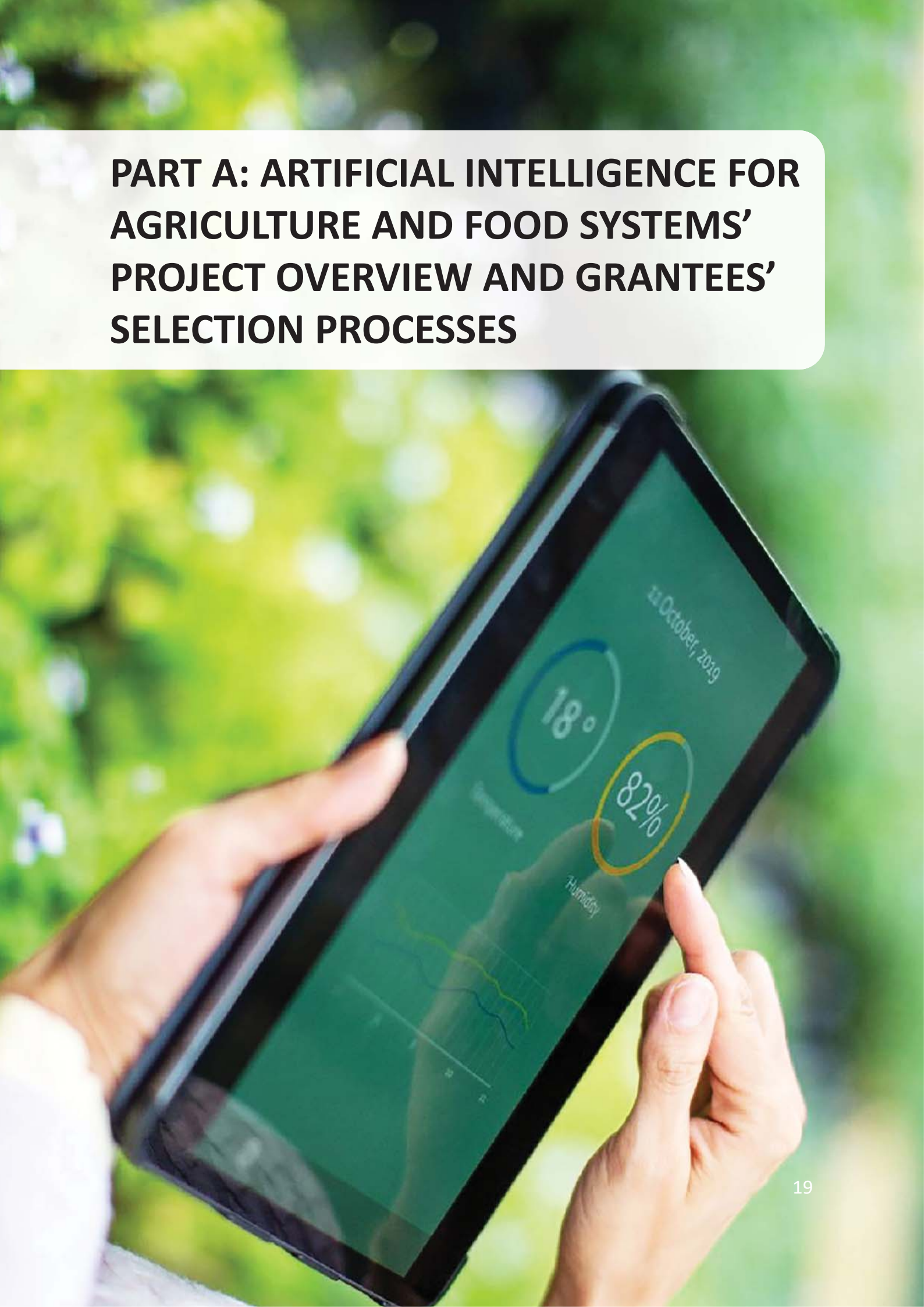
The African Technology Policy Studies Network (ATPS) is a trans-disciplinary network of researchers, policymakers, private sector actors, and civil society actors that promote science, technology, and innovation (STI) for African development, environmental sustainability, and global inclusion. With its Headquarters located in Nairobi, Kenya where it enjoys diplomatic privileges and immunities accorded other International and United Nations Organizations, the ATPS implements its activities through its National Chapter Offices distributed across 30 countries (27 in Africa and 3 in the Diaspora – Australia, UK, and USA). The ATPS has over 5,000 network members and 3,000 stakeholders in over 51 countries in 5 continents, with institutional partnerships worldwide. The ATPS is the lead organization in the AI for Agriculture and food systems project, administering and coordinating all activities of the Hub. As the lead organization, ATPS ensure a transparent selection of the research/innovation project proposal. Additionally, the organization leads in research synthesis, knowledge mobilization, and training of network grantees, specifically in the translation of knowledge outputs into policy products such as policy briefs for sustained impacts. The ATPS will also lead in all policy dialogue, knowledge brokerage, and network collaboration activities of the Hub. The organization's mission is to build Africa's capabilities in science, technology, and innovation for sustainable development and global inclusion. The ATPS Phase VIII Strategic Plan, 2017-2022 identifies four thematic priority areas of intervention, including Agriculture, food, and nutrition, Energy, Climate change, and environment, and Health innovations. The Strategic Plan also identifies five cross-cutting programmatic priority areas to deliver on the overall and specific objectives of the Artificial Intelligence for Agriculture and Foods System Hub. For more information, kindly visit the ATPS website at: https://atpsnet.org/

The International Centre of Insect Physiology and Ecology (icipe) is an inter-governmental organization operating in 41 African countries with over 500 staff and 300 partners globally. icipe's core focus is building the capacity of people and institutions to respond to Africa's development needs, particularly in training young scientists and informal training of extensionists, National Agriculture Research Systems staff, and farmers. The organization's DMMG Unit comprises seven scientists who utilize advanced mathematical, physical, AI, and DS methods and tools to track and predict pest trends, linkages, interactions, relationships, and mechanisms worldwide. The team's research activities are aimed at developing new computational techniques for decision support in the context of AFS, Integrated Pest Management implementation and practices, and climate change and variability impact assessments. icipe is committed to reducing the use of persistent organic pollutants for pest management as a Stockholm Convention Regional Centre, collaborating with the World Organization for Animal Health for Bee Health in Africa, serving as an FAO Reference Centre for Vectors and Vector-borne Animal Diseases, and partnering with WHO-AFRO for Vector Management. The organization has contributed to the AI for Agriculture and food systems innovation network by guiding

grantees with its scientific expertise, selecting high-quality research projects, increasing skills, knowledge, and leadership, providing backstopping in research and science application of AI, and training and capacity building of the grantees. Website: http://www.icipe.org/

Kumasi Hive is a technology and innovation hub in Ghana that aims to build the capacity of young people in technology and business while creating sustainable innovations that solve local and global challenges. It supports entrepreneurs and innovators of all types and provides access to shared working spaces, Biolab and Makerspace with shared advanced manufacturing tools/ resources that strengthen the goal of rapid prototyping of ideas. The Hive focuses on bridging the existing Digital and tech skills gap in the African digital entrepreneurship ecosystem and seeks to address it through integrated innovation. It provides training covering emerging technologies such as IoT, biotechnology, blockchain, mobile app/game/web development, AI, virtual/ augmented reality, and 3D printing. Kumasi Hive also runs a training academy school for courses on augmented reality, hardware garage, IoT, code school, drone and UAVs, robotics, 3D printing/3D modelling, mobile app/game/web development, and AI. It also incubates selected promising hardware start-ups, helping them move from the idea stage through prototyping to the product-for-market stage with both technical and business development support. Kumasi Hive will offer these supports to the Hub. Kumasi Hive, as a private sector practitioner and entrepreneur is providing valuable inputs in internally determining the potential practical impacts of the AI research and innovation projects and how they can transit to commercially viable products and services for AFS. It will provide linkages with the private sector for the provision of much-needed research infrastructure, incubation facilities and expertise in AI. Website: https://kumasihive.com/

PART A: ARTIFICIAL INTELLIGENCE FOR AGRICULTURE AND FOOD SYSTEMS' PROJECT OVERVIEW AND GRANTEES' SELECTION PROCESSES



Overview of the AI4AFS project

Africa's population is expected to reach about 2.6 billion by 2050. This will require an increase in agricultural and food production by up to 70% to fit the need of the population, a serious challenge for the agriculture and food systems. Such requirement, in a context of resource scarcity, climate change, COVID-19 pandemic, and very harsh socioeconomic conjecture, is difficult to attain without the intervention of emerging technologies and innovations such as artificial intelligence to leapfrog the transformations required in the sector. The overall objective of this initiative, therefore, is to advance the responsible development, deployment, and scaling of homegrown artificial intelligence research and innovations to tackle pressing challenges in agriculture and food systems in Africa.

Three sets of interventions have been proposed by the managing organizations (Hub) to achieve the stated objective. These include setting up an artificial intelligence innovation research network for agriculture and food systems; managing the innovation research network; and fostering collaborations, knowledge exchange and valorisation among the network and beyond. It is expected that through these interventions, responsible and homegrown artificial intelligence research and innovations will be developed, deployed and scaled to tackle pressing challenges in agriculture and food systems in Africa. New and high-quality skills and capacity, learning opportunities and collaborations, and new policies and strategies will be developed through the interactions of science-policy-practice systems in the network to sustain a continued application of artificial intelligence research and innovations in transforming agriculture and food systems in Africa.

Goal of the AI4AFS

The general goal of the innovation research network is ***to advance the responsible development, deployment and scaling of home-grown AI innovations to tackle pressing challenges in agriculture and food systems in Africa.*** Achieving this objective would make a significant contribution to agriculture, food and nutritional security as well as enhance the livelihoods of African people especially women and youth who form the majority of the small-scale farmers in Africa. By developing, deploying and scaling AI innovations that are homegrown, peculiar agricultural production and productivity challenges unique to Africa can be addressed. Overall, there will be adequate endogenous capacity, technology and innovations, infrastructure, and enabling policy environment to tackle pressing AFS challenges to achieve sustainable transformation in the sector and overall economies on the continent.

Objectives

The specific objectives of the research network are to:

i) Deepen understanding of how to develop, deploy, and scale responsible AI innovations for sustainable AFS in Africa;

ii) Build the capacity of African innovators and researchers to develop, deploy and scale such AI applications in AFS; and

iii) Facilitate knowledge exchange and the contribution of African research to relevant international AI policy and practice conversations.

Core activities of the Project

The implementation of the research network was organized in three different Work Packages (WP) for ease of management, administration, implementation, reference, accountability and budget allocations. Each of the three WPs addresses aspects of the specific objectives of the research network.

The three WPs are:

1. *Setting up of the AI4AFS innovation Hub and selection of research network grantees;*
2. *Management and administration of the AI4AFS innovation research network; and*
3. *Knowledge valorisation, exchange and collaboration in the research network.*

Key achievements of the AI4AFS Hub so far

The key achievements of the innovation research network Hub are:

1. *Successfully selected 10 innovation research network grantees that are equitably distributed across 8 sub-Saharan African countries namely Cabo Verde, Ghana, Kenya, Malawi, Nigeria, Senegal, Tanzania, and Uganda with the representation of English, French, and Portuguese languages.*

2. *Enhanced the capacity of the innovation research network grantees in the area of responsible data collection and management, ethical research design and methods, and responsible carbon footprint reporting through series of virtual training workshops and engagements.*

3. *Mainstreamed gender equality and inclusive principles in the selection of the grantees and in the implementation and monitoring of grantees' projects.*

4. *Enhanced creation of awareness on responsible AI development and deployment through participation in international workshops and webinars and publication of a working paper on the "Responsible Artificial Intelligence for Africa's Agriculture and Food Systems: Challenges and Opportunities. African Technology Policy Studies Network (ATPS)." Working Paper Series No. 80. https://atpsnet.org/wp-content/uploads/2023/03/Responsible-Artificial-Intelligence-for-Africas-Agriculture-and-Food-System-Working-Paper-80.pdf.*

5. *Documented Grantees' unique datasets in local crops and agricultural practices that will enhance the development and deployment of responsible AI applications in Africa for Africans.*

Selection and Evaluation of the AI4AFS Innovation Research Network

The selection of the innovation network grantees was a two-step process of Call for Expression of Interest and Call for Full Proposals. The Hub adopted the two-step process to ensure that participants are fairly evaluated and gained a measure of skills through the pre-proposal training programmes organized for the potential Grantees by the Hub.

Thematic Areas

The call for expression of interest and full proposals had four (4) thematic themes of food security (Availability, Access, Stability and Utility), All selected application cut across these key thematic areas with 70% of the application having the component of food availability.

Selection of quality Concept Notes for EoI

The call for expression of interest was launched on 28 March 2022 and closed on 10 May 2022. At the close of submissions, a total of107 EOIs were received from 23 countries in sub-Saharan Africa (SSA), through the survey Monkey apply platform.

The use of the Survey Monkey apply platform assisted in collation and initial due diligence that was conducted on the 107 applications. Figure 1 shows the regional distribution of the 107 applications received across the SSA; 49 applications were received from West Africa, 46 from Eastern Africa, 7 from Southern Africa, and 5 applications from Central Africa.

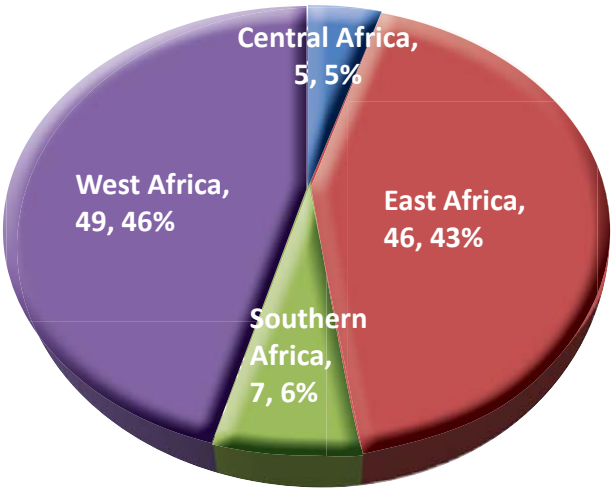


Figure 1: Regional distribution of the EOI Applications received

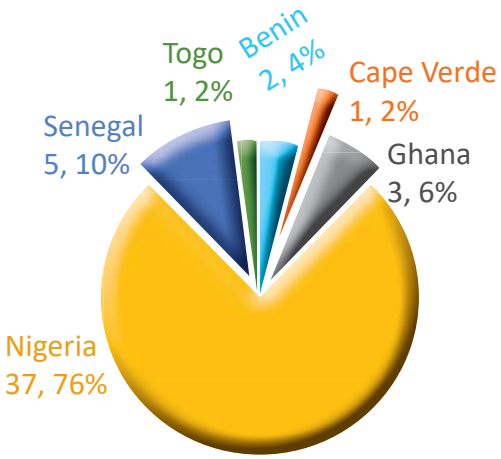


Figure 2: Distribution of application from countries in West Africa

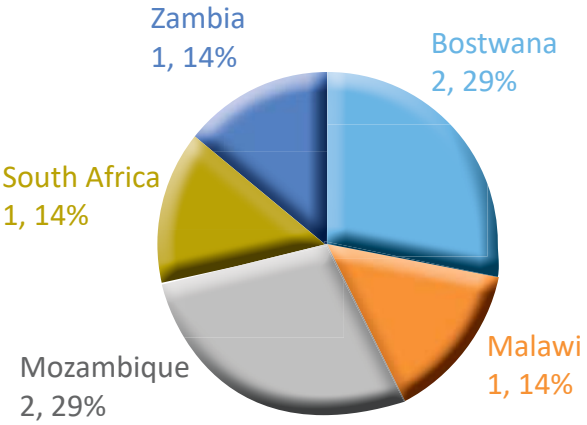


Figure 4: Distribution of application from countries in Southern Africa

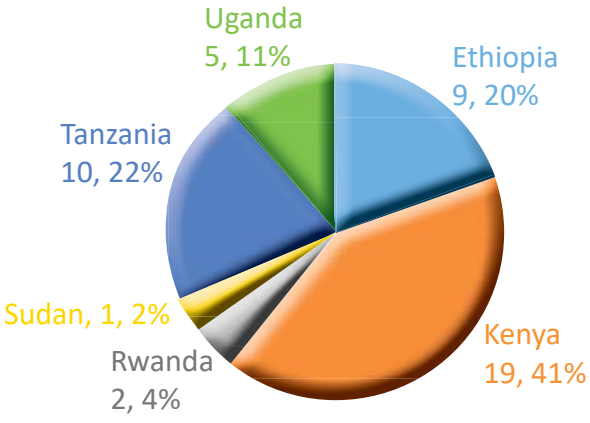


Figure 3: Distribution of application from countries in East Africa

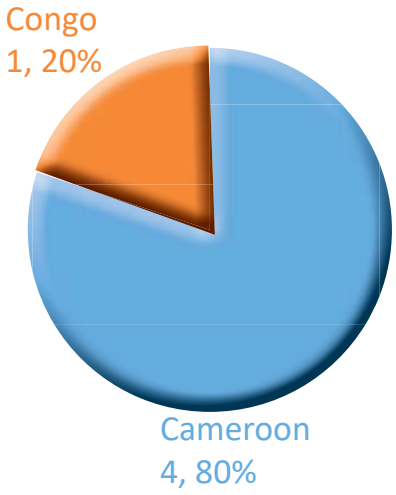


Figure 5: Distribution of application from countries in Central Africa

Gender Analysis of the EOI Applications

The EoI Applications received validate the understanding that women are in the minority in AI research in Africa as seen from the gender analyses in figure 6

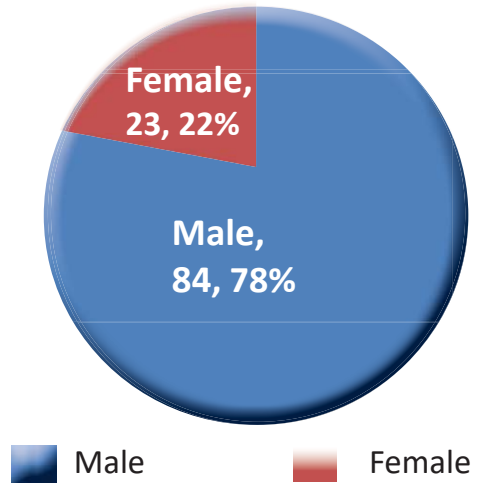


Figure 6: Distribution of male and female lead applicants from the 107 EOI applications received

Process of selecting 28 concept notes

The eligibility criteria for initial screening of the 107 applications were team composition (consortium of organization from private, research, and CSOs), Gender composition of team; lead applicant and organization must come from sub-Saharan Africa, language (English, French, and Portuguese). After due diligence by the Program Implementation Team (PIT), 28 EoIs were selected for the first round of reviews.

Criteria for due diligence check on EoI applications received

1. The team composition must reflect a strong partnership among three institutions drawn from research/ universities; private sector; and civil society organizations/ NGOs/ Think Tanks.
2. The lead organization must have submitted all the necessary documents required including letter of support for government institutions or Certificate of incorporation or registration for private sector and CSOs/ NGOs/ Think Tanks.
3. The budget is between USD 40,000 and USD 60,000.
4. The partners' names are listed, and all support letters are attached.
5. The lead applicants are from SSA countries.
6. Lead applicants must have a minimum of a degree in a relevant field.
7. Priority is to be accorded to teams with gender balance.

The External Review of the EOI.

Earlier, the program implementation team (PIT) reached out to experts across Africa to build the capacity of the AI4AFS network Hub in supporting the selection of the AI4AFS innovation research network grantees. The experts were to further assist in training and continuous technical support to the Hub and the network grantees to deepen the network capacity to develop, deploy, and scale responsible AI tools and products to leapfrog Africa's agriculture and food systems.

The contact details of these experts were added on the ATPS interactive collaborative environment (ICE). For information about these experts, please visit https://atpsice.org/ai-experts/. From the list of experts, 28 were identified with specialty in the field of AI, data science, computer science, electronic engineering, agricultural engineering, and mechatronic engineering.
These 28 experts were contacted to express their willingness to review the EoI applications. Seventeen (17) experts were finally selected to review the 28 shortlisted EOI. The review assignment started on **20th May 2022 and was concluded on 3rd June 2022.**

Criteria for assigning external reviewers for the AI4AFS EOI

The following are the criteria used for assigning reviewers for the AI4AFS EOI:

1. Every proposal was to be reviewed by at least three External Reviewers
2. Out of the three External Reviewers, only one is allowed to come from the same country with the applicant to provide assessment on local content that may be necessary in the proposal. The rest must come from outside the applicant's country.
3. The reviewer will not have published or co-researched with the applicant.
4. The reviewer is not part of any applications.
5. The reviewer has signed the AI4AFS non-disclosure Agreement.

Gender composition of the reviewers

In line with mainstreaming the GEI principles, the AI4AFS Hub ensured proper representation of gender in the selection of the external reviewers. Figure 7 shows the distribution of gender among the selected external reviewers.

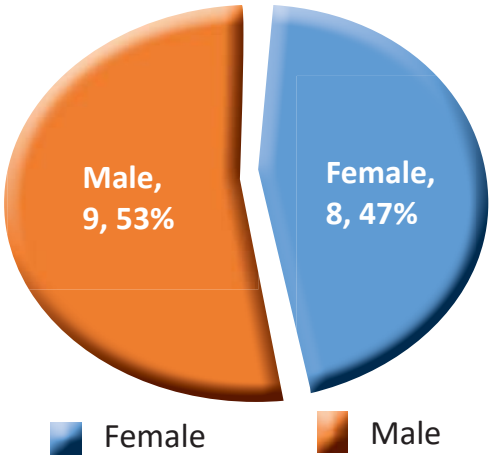


Fig. 7 Gender distribution of the expert reviewers.

Training of the reviewers

A training webinar was organized for all selected 17 external reviewers to build their capacity in evaluating the EoIs. The training centred around understanding the objectives of the programme and selecting EoI that clearly shows alignment of their concepts with the overall goal of the initiative as well as with the GEI principles, responsible AI, and responsible carbon footprint reporting.

Other areas that they were trained on include the alignment of the proposed projects to the key thematic arrears, identification of teams with relevant experience in area of research and innovation, technical capabilities of the project's methods, impact pathway for achieving responsible AI4AFS, and well-articulated budget. A training video was prepared to assist the reviewers use the survey monkey apply platform. To ensure standard scoring of the EOIs, scoring criteria was developed to guide the reviewers. The same template was created on the survey monkey apply platform for collection of scores.

Selection of 17 EoIs for full proposal Stage

28 concept notes were sent for external reviews, and at the conclusion of the external reviews, 15 concept note/EoIs that had the highest scores and ranked 1-15 were selected; 2 EoIs with considerable high scores were added to the 15, to bring the total number selected to 17 concept notes. Their selection was based on our determination to be inclusive, hence their addition was based on language (Portuguese and French) and equitable distribution of the grantees across SSA. The selection was presented to the Hub Management Committee (HMC) for ratification. At the Fifth Hub Management Committee Meeting held on 08 June 2022, the 17-concept note were approved to move to the full proposal stage.

The breakdown of the 28 applications reviewed showed that the highest score by an applicant was 86% while the lowest score was 44%. The 17 concept notes shortlisted had **6 female leads,** and **11 male leads.** In respect to language composition of the 17 EoIs shortlisted, there were **3 French** applications, **2 Portuguese** applications, and **12 English** applications.

The Regional breakdown of the selected applicants are summarized as follows:

- East Africa – 6 applications [Kenya (3), Tanzania (2), Uganda (1).]
- West Africa – 7 applications [Nigeria (3), Ghana (2), Senegal (1), Cape Verde (1).]
- South Africa - 2 applications [Mozambique (1), Malawi (1).]
- Central Africa - 2 applications [Cameroon (2).]

Call for Proposals

On 8th June 2022, the Hub Management Committee (HMC) during the **7th monthly** meeting approved that the Call for Proposal (CfP) document be shared among the partners and their inputs harmonised. The HMC approved that the CfP be launched on 13th June 2022 with the deadline for submission of the proposal from all applicants set at 13th July 2022. The **AI4AFS** CfP document was harmonised and shared to all the 17 shortlisted applicants on the 13th of June 2022.

The call document contained information on the pre-training workshop survey link to determine the training needs of the applicants. The CfP contained checklists for gender equality and inclusion and carbon footprint reporting for the proposed project.Thischecklist was an addition and an improvement onthe EOI call document. To make sure that all applications and processes are in line with responsible AI development and deployment, the AI4AFS Hub adopted and modified the **ItechLaw template for responsible AI assessment,** in addition to writing the GEI considerations and the carbon footprint pathway for the proposed project and its activities.
The highlight of the CfP was the modified assessment criteria. The assessment criteria had clear focus on the theoretical background to the methods to be used, project governance structure, and knowledge mobilization strategy.

The assessment criteria focused on six main areas namely:

i) ***Qualifications and team composition*** (10%): The team must be multidisciplinary, gender-sensitive, inclusive, and equitable. The team must comprise of a research institution (government or private), private sector, and civil society organization teams/ Think Tanks, including but not limited to government, private sector, academia, farmer associations, and agribusiness entrepreneurs, which are highly encouraged and will be an added advantage. Support from government parastatal overseeing relevant sectors is an added advantage.

ii) ***Experience in the relevant area of research and innovation*** (10%): The team must prove that they have relevant experience in the chosen field of endeavour demonstrated by previous project references and track record as will be shown in the proponent's CVs.

iii) ***Technical capabilities*** (25%): The Proposal must align with the overall objective of the AI4AFS and the identified thematic priority areas. It must have clarity on the aim and objectives, research/innovation designs and methods, activities, outputs, outcomes, impact, and sustainability.

iv) ***Knowledge - mobilization strategy*** (10%): The proposal must show how activities and outputs of the project will engage, on an ongoing basis, potential knowledge users, including ministries of agriculture; the strategies to ensure that research results are used by relevant stakeholders in Africa.

v) ***Responsible AI principles embedded in the research project:*** (10%): The proposal must demonstrate a clear pathway for integrating all RAI principles in all AI development and deployment activities. It must also contain a clear pathway for carbon footprint reporting in all activities.

vi) ***Gender Equality and Inclusion*** (10%): The project shows a clear path to gender support and inclusion in the project activities, including machine learning

algorithms, training, engagements, and workshops.

vii) **Carbon Footprint Reporting** (10%): The proposed project demonstrates how the carbon footprint of all activities, especially machine learning processes, will be tracked. A clear statement of how the project will adapt to the green activities' pathway is an added advantage.

viii) **Governance structure** (5%): The team must demonstrate how it will be governed and managed to accomplish the stated objectives.

ix) **Budgeting** (10%): The proposed project must demonstrate clear and coherent plans for the use of available funds for the proposed project activities.

Final Selection Process of AI4AFS Network Grantees

The processes involved in the final selection of the network grantees were; Pre-training workshop for the proponents; submission of proposals by the 17 applicants shortlisted from the EoI stage; due diligence on the submitted proposal, the final review of the proposals; and the selection of the network grantees.

Pre-training Workshop for the AI4AFS Proponents

A pre-training workshop was organized for the 17 proponents from22-23 June 2022to provide them with more information on the overall goal of the AI4AFS innovation research network project. Most importantly, the workshop provided the proponents with the opportunity to present their project ideas among their peers and broker some partnerships and collaborations especially between proponents with similar ideas. The platform further offered the opportunity to address some questions and inquiries from the proponents to enable them to submit high quality proposals.

Submission of full Proposal and due Diligence

At the expiration of the deadline for submission of proposals (13th July 2022; 23:59 EAT (GMT+1), 16 proposals out of the 17 EoI shortlisted were received; the 17th application requested for extension of time due to network issues, the Program Implementation Team obliged for eight (8) hours. The applicant did not submit; hence 16 proposals were evaluated internally to determine if the requirements were met for review stage. The due diligence was conducted in line with criteria on team composition, which requires a consortium of multidisciplinary teams that are gender-sensitive, inclusive, and equitable. Each consortium must be made up of the following entities:

i. Research institutions (public research institutions/government organizations/ universities) comprising scientists, policymakers, engineers, agriculturists, etc.

ii. Private sector entities including Micro, Small and Medium-scale Enterprises (MSMEs), Entrepreneurs, Innovation hubs/parks, etc.

iii. Civil Society actors including Think Tanks, Rights-based Organizations, NGOs, Consumer Organizations, etc.

From the due diligence conducted, seven (7) proposals had the three entities (research, private sector, civil society) in its team composition; another seven (7) proposals had two entities in its team composition,

while two (2) proposals had one (1) entity in its team composition. At the conclusion of the due diligence, 14 proposals scale the check on team composition and two (2) dropped for lack of the entities required for team composition. The fourteen (14) proposals shortlisted after due diligence weremoved to the final stage of proposal reviews.

Selection and Assignment of Reviewers

For the full proposal reviews, eleven (11) reviewers were selected from the earlier pool of experts used for the EoI stage. The following are the criteria used for selecting and assigning reviewers for the Proposals;

1. The reviewer should not come from the same country as the applicants
2. Proposals from West Africa would be assigned to applicants from Southern Africa or Eastern Africa, or Central Africa and vice visa;
3. Each proposal will be reviewed by three (3) independent experts with one (1) reviewer from the region of the proposal.
4. The reviewer will not have published or co-researched with the applicant.
5. The reviewer is not part of any applications.
6. The reviewer has signed the AI4AFS non-disclosure Agreement.

The review assignment started on 14th July 2022 and was concluded on 30th July 2022.

Expert Reviewers for the selection of AI4AFS Innovation Research Grantees

Details of Reviewers	Sex
Patrick Kinyua Gikunda Artificial Intelligence researcher, Dedan Kimathi University of Science and Technology,Kenya	M
Joseph K. Mung'atu Statistician and a University Lecturer. Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya.	M
Samuel Musili Mwalili Research Scholar on AI at Jomo Kenyatta University of Agriculture and Technology, Nairobi, Nairobi County, Kenya	M
Albert Njoroge Kahira Research scientist Jülich Supercomputing Centre, Germany	M
Kennedy Senagi Data scientist, Icipe, Kenya	M
Tatenda Duncan Kavu Researcher, African Leadership University, Kigali, Rwanda	M
Seydou Nourou Sylla Data Scientist/ Machine learning researcher, DIT, Senegal	M
Mouhamad M. Allaya Assistant Professor, Thies University, Senegal	M
Talaat MohyEldin Wahby Elamin Associate Professor, Sudan University of Science and Technology, Sudan	M
Adimora, Kyrian Chinemeze Lecturer, University of Agriculture, Umudike, Nigeria	M
Ozoemena Anthony Ani Lecturer, University of Nigeria Nsukka, Nigeria	M
Fredrick Mzee Awuor Lecturer, Kisii University, Kenya.	M
Deborah Dormah Kanubala Natural language processing(nlp) engineer, Proto, Germany	F
Salomey Osei, ML Engineer, Deustotech, University of Deusto., Ghana/ Spain	F
Tejumade Afonja Machine Learning Researcher Helmholtz Center for Information Security team | Mario Fritz Lab, Germany	F
Ogechukwu Iloanusi Professor, Department of Electronic and Computer Engineering, University of Nsukka, Nigeria	F
Niemah Izzeldin Mohamed Osman,Assistant Professor, Sudan University of Science and Technology, Sudan	F
Ivone Muocha, Researcher, Centre for Research and Technology Transference for Community Development, Ministry of Science, Technology and High Education, Mozambique,	F
Ijeoma Ezika, Senior Lecturer, MAAMI Nigeria/ University of Nigeria, Nsukka., Nigeria	F
Professor Mpho Raborife,Computational linguistics. Institute for Intelligent Systems, University of Johannesburg, South Africa.	F

Shortlisting of Network Grantees

The review results as seen in figure 8 show that the highest total score was 83.83 and the minimum score was 34.50. The program implementation team decided to select 10 proposals out of the fourteen (14) that were reviewed. From the selected proposals, the highest score was 83.83 and the lowest score was 56.17. The selected ten (10) grantees had five (5) female and five (5) male principal investigators drawn from three (3) major languages in Africa, namely English, French, and Portuguese, with a spread across eight (8) sub-Saharan African countries namely Cabo Verde, Ghana, Kenya, Malawi, Nigeria, Senegal, Tanzania, and Uganda.

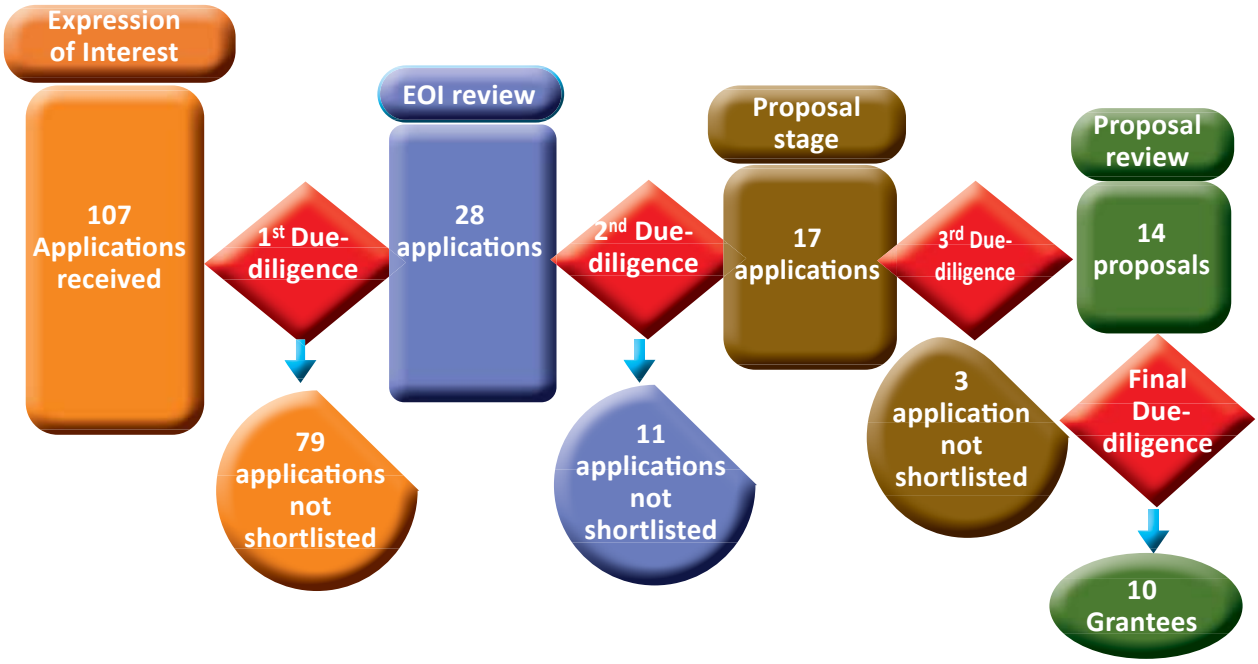


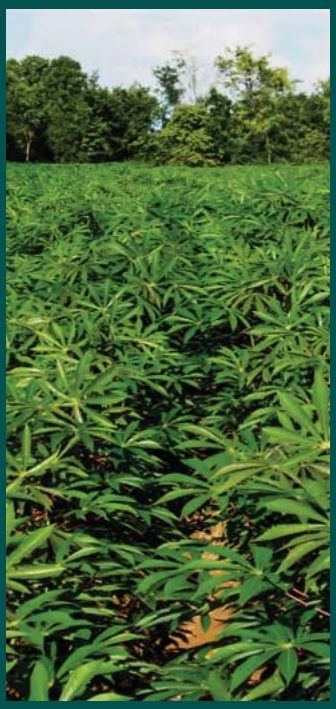
Fig. 8 The Selection process of the network grantees at a glance

PART B: PRESENTATION OF THE 10 FUNDED AI4AFS PROJECTS

Project 1: Monitoring and Artificial Intelligence Tools for Smart Agriculture.

Principal Investigator: Dr Sónia Semedo
Organization: Universidad e de Cabo Verde
Project Amount: US$ 50,000.00 (US Dollar Fifty thousand only)
Grant Award Number: AFS-9957569475
Country of Implementation: Cape Verde

Project Partners
Co-PI 1: Claudio Gonçalves
Organization: Associação de Produtores da Ribeira de São Filipe (APRSF), Cabo Verde
Co-PI 2: Érico Fortes
Organization: PrimeBotics, Cabo Verde



Goal

The main goal of the project is the use of Internet of Thing and Artificial Intelligence solutions suitable for Cape Verde to increase the production level that allows mitigation and increased resilience in the face of climate change.

Objectives

The specific objectives of the study are to:

1. Develop a wireless sensor network to monitor soil, weather conditions and water availability;
2. Develop a drone for crop mapping.
3. Create a database for AI training and evaluation.
4. Implement a pilot system.

These objectives are aligned with two of the four priority areas of Agriculture and Food Systems, Availability and Stability. The project is developing a farm management system to perform automatic irrigation and drone mapping of crops. It will also conduct training and knowledge exchange through capacity building of students and farmers in the rural community drone controller and smart agriculture system.

Key activities

- Project inception meeting
- Project in debt literature review documenting specifications for IoT and AI models; documentation about drone and wireless sensor network specifications
- Identify with the community partner pilot land for mapping and project implementation.
- Develop a wireless sensor network to monitor soil, weather, and water.
- Build a drone for crop mapping.

Key Achievements

The key projects achievements identified during the review of the progress report are as follows:

- Identification of the 3 plots of land where the pilot project will be implemented,(14.955380554321751, -23.51010696300595) with a total area of 4000 m2 for the implementation of the pilot.
- In-depth literature review and identification of trends in the use of IoT and Artificial Intelligence models in smart agriculture.
- Successfully tested the system that monitors weather parameters (windspeed, air temperature and humidity, precipitation, wind direction), soil parameters (soil moisture and temperature).
- 3D printing of the components and mounting of the weather station,
- Development of the soil monitoring system prototype and electronic valve actuator; and
- Setting up a prototype in the laboratory.

Next Steps

Future activities will involve creation of the application for integrating sensor data, preparation of the field for installation of the pilot (construction of the tank and adaptation of the electronic valve); data collection for the creation of AI models; training of students and farmers in drone piloting and operation of smart agriculture system; and dissemination of results .Since the design of the pilot was defined together with the farmers by adding minor adaptations to the existing drip irrigation system it is possible for other farmers to adopt the technology allowing for scale up the product.

Project 2: Development of Machine Learning Model for Crop Pests and Diseases Diagnosis Based on Crop Imagery Data.

Principal Investigator: Dr. Hudson Laizer
Organization: Mbeya University of Science and Technology
Grant Amount: US$ 51,000.00 (US Dollar Fifty-one thousand only)
Grant Award Number: AFS-2504001568
Country of Implementation: Tanzania

Project Partners
Co-PI 1: Dina Machuve
Organization: Dev Data Analytics, Tanzania
Co-PI 2: Adam Siwingwa
Organization: Southern Corridor Alliance of Agriculture Producers, Tanzania

Goal

The goal of the project is to develop a Machine Learning models for early detection of Common bean and Irish potato diseases in the Southern Highlands regions of Tanzania.

Objectives

The specific objectives of the study are to:

1. To assess farmers' knowledge and perceptions on Artificial Intelligence, Machine Learning, pests and disease management in Common bean and Irish potato farming.
2. To collect high-quality imagery data for healthy and diseased Common bean and Irish potato crops.
3. To annotate and prepare the collected image data for Machine Learning models development.
4. Train and build capacities of farmers, agricultural extension officers and other stakeholder.

Key activities

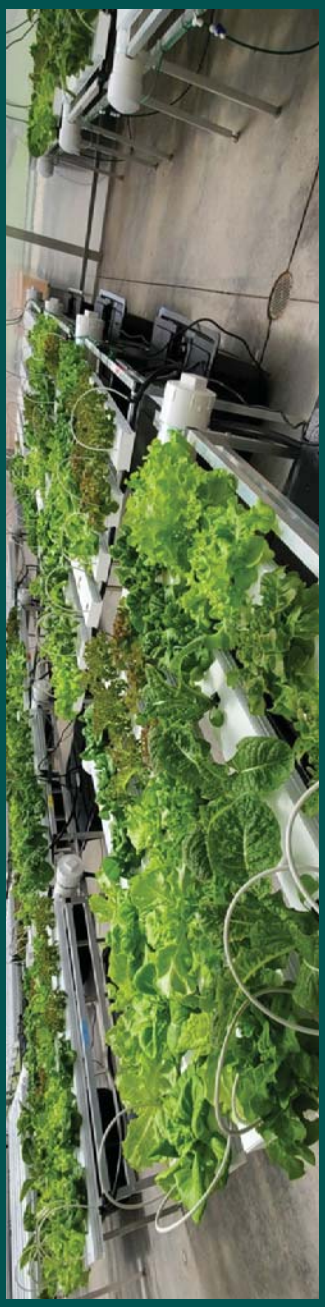
The key activities for the six months of the project where:

- Inception meeting for project stakeholders to communicate the project objectives, responsible AI practices, risks and

- Enrolment of farmers to the project with the goal of Identifying with the community partners
- Development of data collection tool using ODK
- Training of project team and enumerators on using digital data collection tools
- Initial data collection for tool testing and verification

Key Achievements

1. The project team has collected field data and are verifying the uploaded data. The target was 120,000 but have managed to collect 129,500 images for all classes. The dataset that has been pre-processed for machine learning is a total of 36,000 images. The data exploration activity involved baseline training of models for image classification and object detections tasks. 500 images were used from each class to ensure all classes are balanced. The standard GPU on Google colab environment was used to train the baseline models.
2. The project PI (Dr. Hudson Laizer) and ML expert (Dr. Neema Mduma) presented the project work in Black in AI workshop co-located with NeurIPS 2022 Conference in New Orleans, Louisiana, United States of America. The workshop enabled the project team to establish both formal and informal networks with other researchers in the field of AI and ML for future collaborations.



Next Steps

The image pre-processing work is ongoing to reach the target of 120,000+ images for six classes. The dataset that will be shared in ATPS open repositories. The project team will train more model architectures for image classification and object detection for suitable model selection on deployment on mobile application. After model development and testing, the project team will organize workshops, training and dialogues where participants including smallholder farmers, government officials, private sectors etc. will be engaged to discuss matters of mutual benefits. The engagement of multiple stakeholders during dissemination of project results is important not only in sharing project outcomes but also in collecting the diverse opinions that will help to identify any need for policy review and change 2.2.4 Gender equality and inclusion action.

Project 3: Enhancing Farm-scale Crop Yield Prediction using Machine Learning models for Internet of Agro – Things in Tanzania.

Principal Investigator: Dr. Barakabitze Alcardo Alex
Organization: Sokoine University of Agriculture, Tanzania
Grant Amount: US$ 51,000.00 (US Dollar Fifty-one thousand only)
Grant Award Number: AFS-3882447997
Country of Implementation: Tanzania

Project Partners
Co-PI 1: Dr. Dominic Ringo
Organization: Research Community and Organizational Development Association (RECODA), Tanzania
Co-PI 2: Mr. Adam Rowland
Organization: SAHARA Ventures, Tanzania

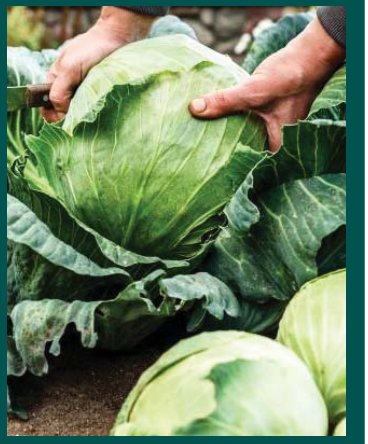
Goal

The overall objective of the project is to develop reliable and reusable ML-driven crop yield prediction models using historical meteorological data, satellite data and proximal sensor data to enhance crop yield predictions in Tanzania.

Objectives

The specific objectives of the study are to:

- To develop a model that utilizes historical multi-source data to predict maize and sorghum yield at the district level using climate reanalysis data, satellite imagery data, weather data, soil data, and proximal IoT data to train machine learning models to predict district-level yield data.
- To deploy a small-scale smart farming system using low-cost Internet of Agro Things (IoAT) sensors and interactive cloud-based big data analytics to monitor and evaluate crops' performance in real-time.
- To pilot a big data model to predict farm-level yield using low-cost agricultural Internet of Agro Things (IoT) sensor data by enhancing district-level resolution yield



data to farm-level resolution yield data using Generative Adversarial Networks (GANs).

- To conduct the economic feasibility of using agricultural IoT and big data for small-scale farm monitoring and yield prediction.
- To formulate a data-driven policy brief on crop prediction using multi-source big data. The research will identify and reach potential farmers to use agricultural IoT.

Key activities

The key activities for the first quarter where:

- Inception workshop conduction and engagement with farmers
- Data collection from the online dataset repository (Historical data of 14 years for prediction of crop yields).
- Cleaning and formatting of historical dataset for machine learning (ML) application
- Acquisition of IoAT devices for the project
- Discrete-level prediction model development and testing.

Key Achievements

The key projects achievements identified during the review of the progress report are as follows:

- The development and implementation of the agriculture - Internet of Agro -Things (IoATs) ML- based farming monitoring and management system. The developed prototype can help smallholder farmers to see different farm attributes like temperature, humidity, soil moisture which are directly seen or observed through a farmer's Smartphone App.
- Conducted workshop on importance of developing innovative approaches for predicting crop yield using machine learning and Internet of agro-things sensors to increase agriculture productivity of smallholder farmers in Tanzania.
- Preparation of demonstration farm regarding enhancing crop yield prediction using ML and IoT at SUA farming sites. This demo farm is being implemented in collaboration with the NEGGROW company that has been contracted to work on the installation of IoT sensors in the farm.
- Collected yield data from maize and sorghum crops from Lindi, Morogoro and Dodoma regions. These data will

be used for the development of ML – driven crop yield prediction models.

- IoAT has been developed. The project has conducted initial prototyping and helping smallholder farmers to see different farm attributes like temperature, humidity, soil moisture which are directly seen or observed through a farmer's Smartphone App. We have also been able to programme the hardware by imbedding and linking them with web applications. The developed prototype has been tested at SUA farming sites available at the Sokoine University of Agriculture

Next Steps

The project team plans to develop and test a real-time analytics dashboard for the Internet of Agricultural Things (IoAT), as well as a farm-level prediction model, data augmentation, and economic analysis in Tanzania. Feedback will be gathered from smallholder farmers through focus group discussions, interviews, and questionnaires. A policy brief will be developed to encourage adoption of the ML tools by farmers in Tanzania and Africa. The project will be scaled to include the Dodoma region and will be replicated at the Dodoma farming blocks where youths are being trained in digital agriculture. A research paper will be submitted to the Agriculture and Electronics Elsevier Journal for publication considerations. Finally, training workshops will be conducted with farmers to demonstrate the tools' innovativeness and credibility.

Project 4: Using Artificial Intelligence to enhance the Production, Management and Marketing of Nsukka Yellow Pepper (Capsicum Chinese Nsukkadrilus).

Principal Investigator: Engr Prof. Chinenye Anyadike
Organization: Association of Professional Women Engineers of Nigeria
Grant Amount: US$ 59,000.00 (US Dollar Fifty-nine thousand only)
Grant Award Number: AFS-0575120455
Country of Implementation: Nigeria

Project Partners
Co-PI 1: Engr Alex Onyia
Organization: Educare Nigeria
Co-PI 2: Dr Cynthia Nwobodo
Organization: University of Nigeria, Nsukka, Enugu State, Nigeria

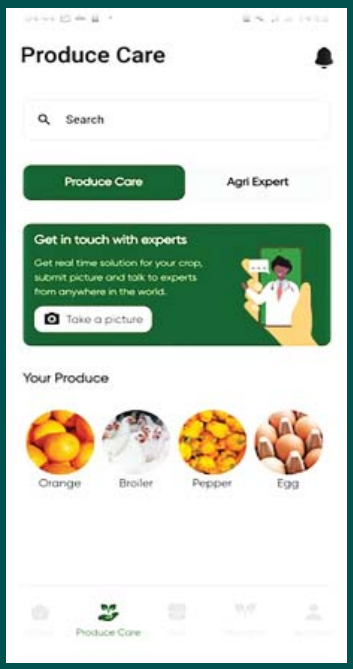
Goal

The overall objective of this project is to develop and deploy Artificial Intelligence to improve the productivity and yield of Nsukka Yellow Pepper by strengthening the resilience of farmers in adapting to climate change, applying mitigation strategies, and thus empowering the women and youths.

Objectives

The specific objectives of the study are to:

- Analyse and review gender dynamics, practices, and institutional support gaps in Nsukka yellow pepper production to understand statutes support gaps.
- Co-develop an AI-based pest detection, smart irrigation, nutrient monitoring, and e-extension service application for sustainable production, management, and marketing of Nsukka yellow pepper.
- Co-deploy, monitor, train, and engage stakeholders in the use of AI tools for sustainable production, management, and marketing of Nsukka Yellow Pepper.



Key activities

- Desk review, IDIs, KIIs, FGD to document gaps in the production, management and marketing of Nsukka Yellow Pepper.
- Key team members will pay a visit to the chosen communities and farmers. Meetings will be scheduled with key community leaders as community awareness and project buy-in strategy.
- Data Collection to understand gender dynamics, what works, what does not work, and why. This is to increase gender equality and inclusivity from the start of the project.
- Results and Data Analysis - Analysis of IDIs, KIIs, desk reviews and FGDs.
- Dataset collection of Nsukka yellow pepper leaf for labelling and classification with smartphones
- Development of an AI system on field camera based unhealth leaf detection and communication system
- Development IoT based systems for soil nutrient and moisture monitoring system.
- Development of Smart phone based NYP extension service and marketing application.

Key Achievements

The key projects achievements identified during the review of the progress report are as follows:

- The project has the relevant data on gender dynamics, planting practices, barriers, and technology acceptance in the production, management, and marketing of NYP. In terms of gender dynamics and socio-demographics, we discovered that more women participate in NYP production, management, and marketing. Also, both people with formal education and no formal education are involved in NYP production. Most of the farmers are married and that farmland is obtained through inheritance.
- The project was able to obtain relevant information on the common planting practices such as the use of seedlings and that farmers determine the quality of seedlings/seed by visual observation of physical appearance of the seeds/ seedlings. The use of fertilizers is also a common practice, and the most used fertilizers are NPK and Urea. The effect

of climate change according to farmers is prevalent in increased pests and disease infestation, destruction of plants in fields by flooding, wilting due to drought, rotting of pepper due to heat waves, increased weed infestation.

- The project team understands the major barriers in NYP production, management and marketing that include accessibility to land and difficulty in transportation of goods. Since land is obtained by inheritance, scalability of NYP production is a major challenge for most farmers. Also, transportation of produce to buyers takes an average of 24hrs during which some losses occur.
- Dataset for machine learning activity have been collected through a gender inclusive data collection process. 3000 datasets of healthy and unhealthy leaves of Nsukka yellow pepper have been collected and classified. This is a major achievement of the project as at the time of the start of the project such dataset did not exist.
- The algorithm for the disease detection system has been developed and implementation been carried out.
- The soil nutrient and moisture IoT monitoring systems developed.
- Version 4 of the extension service and marketing app developed, and finalization of the app almost completed for deployment in google play store.

Next Steps

- Deployment and evaluation of the AI systems for monitoring a smart irrigation system on a 10m x 20m demonstration farm with a control.
- On-site demonstrations and training of selected women, youth, and men on the technicalities of the smart farming system.
- Publication of knowledge product
- Organization of farmers into co-operative groups with women leading some of the selected groups and training of the groups on the use of the marketing and extension service app.
- Policy dialogue involving all stakeholders through focus group discussions and engagement with government, private sector, and civil society organizations to buy in into the use of the products and services. This will ensure that there is an insured exit strategy for commercialization.

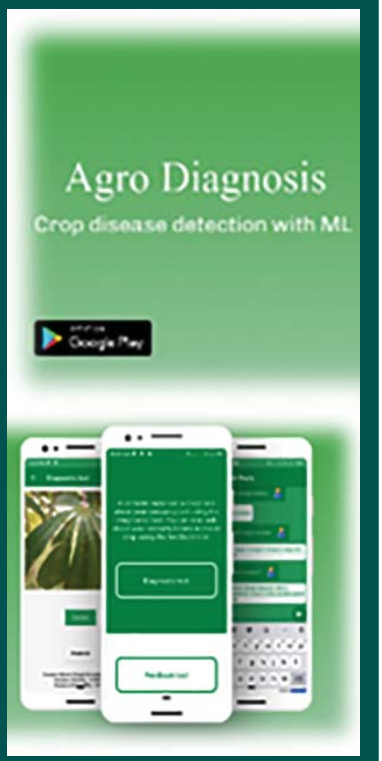
Project 5: Project: Scaling Smart-phone-Based Tools for Early Crop Diseases Detection & Monitoring.

Principal Investigator: Dr. Godliver Owomugisha
Organization: Busitema University, Uganda
Grant Amount: US$ 55,000.00 (US Dollar Fifty-five thousand only)
Grant Award Number: AFS-0163245214
Country of Implementation: Uganda

Project Partners
Co-PI 1: Emmanuel Ofumbi
Organization: Papoli Community Development Foundation, Uganda
Co-PI 2: Evarist Abiine
Organization: Nyakasozi Tukooreamwe Coffee Farmers' Co-operative Society Limited, Uganda

Goal

The overall goal of the project is to create positive impact on the livelihoods of smallholder farmers by availing them with automated disease diagnosis tools for in-field and real-time feedback thus improving on food security and production.



Objectives

The specific objectives of the study are to:

- Scale smartphone applications for crop disease diagnosis and real time advisory information to smallholder farmers.
- Build multimodal machine learning algorithms to predict crop diseases before they are asymptomatic using spectral data.
- To disseminate and pilot the research studies through conferences, workshops, and the communities.

Key activities

- Inception meeting and project planning with partners
- Identification and engagement of smallholder farmers
- Data collection.
- Deployment of mobile diagnostic application.
- Training of farmers to use the mobile tool.
- Construction of a low-cost spectrometry device

Key Achievements

- The constructed portable, low-cost spectrometer device using 3-D printing technology is a breakthrough in the field of agriculture. This innovative device can be easily attached to a smartphone, making it highly accessible and convenient for farmers to use. The key components of this device include its design and the automation of the light spectrum absorbed from the leaf sample. The device has been fully operational and is currently undergoing field testing. Initial data collected using this device has shown distinct plant features, and it is being used to monitor plants in a controlled setup.
- The project has successfully scaled up the usability of our tools beyond the initial pilot phase of 100 farmers. We have built a network of over 500 farmers across Uganda through farmer cooperatives and groups. By educating more farmers about the benefits of phone-based technologies in agriculture, we are improving their quality of life and helping them to become more self-sufficient, without having to rely on experts.
- The study has made significant contributions to the availability of data in spectrometry, imagery, and textual datasets for Natural Language Processing (NLP) models. We have been able to crowd source more data from farmers, including textual, imagery, and audio data, which has been labelled and made publicly accessible. This will provide researchers and practitioners with valuable

information to develop more accurate and reliable NLP models for the agriculture sector. By increasing the availability of data, we can accelerate progress towards more sustainable and productive farming practices.

Next Steps

The implementation of AI-powered tools in agriculture has the capacity to enhance productivity, lower expenses, and advance sustainable practices. Moving forward, the project aims to accomplish the following objectives:

1. Utilise our disease diagnostic tools to gather real-time crop data via crowdsourcing from farmers throughout the region.
2. Leverage our advanced spectrometry add-on tools to sense mobile symptomatic and asymptomatic crops.
3. Combine various modalities to offer a more thorough assessment of crop health and environmental conditions. This step is crucial in unlocking the advantages of AI tools in agriculture and guaranteeing their successful implementation in the industry.

Project 6: Pest Occurrence Early Warning System and Diagnostic Tool Development using Geoinformation and Artificial Intelligence: A Case Study of Tomato Leaf Miner (Tuta Absoluta), and Whiteflies in Machakos County, Kenya)

Principal Investigator: Dr. Hilda Manzi
Organization: Geospatial Research International, Kenya
Grant Amount: US$ 52,000.00 (US Dollar Fifty-two thousand only)
Grant Award Number: AFS-4241717219
Country of Implementation: Kenya.

Project Partners
Co-PI 1: Cosmus Muli
Organization: Kathaana Vegetable Growers, Kenya
Co-PI 2: Joseph Sang
Organization: Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya

Goal

The overall objective of this research is to develop a Spatial based AI web Tool to detect, identify, and monitor leaf miner *(Tuta absoluta)* and whiteflies to allow for the integration and implementation of Integrated Pest Management Solutions in smallholder tomato vegetable farms in Machakos county, Kenya, as a gateway to develop and scale sustainable African agriculture and food systems.

Objectives

1. Use AI to digitize tomato farms in Machakos, Kenya, for improved pest surveillance and management of leaf miner and whiteflies by smallholder farmers.
2. Analyze remote sensing data to establish correlation between environmental factors and occurrence of leaf miner and whiteflies in tomato farms in Machakos,

Kenya, for evidence-driven adoption of integrated pest management practices.

3. Develop an AI-based platform for accurate detection and diagnosis of leaf miner and whiteflies to fast-track cost-effective pest outbreak surveillance and management, leading to increased farm yield among smallholder farmers in Machakos, Kenya.
4. Create a spatial-based web and mobile tool integrating AI, remote sensing, and data mining techniques for early diagnosis and control of leaf miner and whiteflies in tomato farms in Machakos, Kenya.
5. Develop a sustainable business model for AI-based private e-extension services aimed at young women in agriculture for pest disease diagnoses and control measures.

Key activities

- Understanding farmers' knowledge, perception, and management of Tuta absoluta and whiteflies through baseline surveys. This information formed the basis of this study and is assisting in the development of artificial intelligent monitoring tools for these pests.
- Farm demonstration to study Tuta absoluta and whiteflies pest occurrence and populations for the training of the AI models. This involved the collection of land surface temperature data from the field for comparison with pest occurrence and populations.
- Collection of farmer data on the occurrence of Tuta absoluta and whiteflies. This targeted the specific dates in every month for the last six years. The data will enable the training and testing of the machine-learning models.
- Extraction of satellite data products; land surface temperature and soil surface moisture for the last six years to study patterns and trends in temperature and soil surface moisture change for every decadal for six years.
- The design of the early warning system tool for pest monitoring in tomatoes. This will assist in the deployment of the front-end and back-end processes of the system. This also involved the development of algorithms for land surface temperature and soil surface moisture for use in analysing satellite data and the deployment of various outputs via an API from the sentinel hub to the PeMoST tool servers.

Key Achievements

1. Baseline surveys showed that farmers in Kathaana are highly aware of Tuta Absoluta and white flies as well as the severe impact these pests have on tomato crops. This knowledge is important for the development and implementation of effective pest management strategies.
2. Tomato farming is an important part of the Kathaana community, grown both for subsistence and for the market. The project aims to address crop management issues that lead to high variation in yields among farmers.
3. The project aims to address knowledge gaps and improve extension services for farmers. Most respondents were willing to pay for extension services and were interested in using the PeMoST tool to solve pest problems in tomatoes.
4. Pest populations were found to be high in demonstration farms, highlighting the need for effective pest management strategies.
5. The project studied the relationship between land surface temperature and pest occurrence, finding that higher temperatures led to increases in Tuta Absoluta and whitefly populations.
6. The PeMoST tool was designed based on datasets collected from baseline surveys, pest population surveillance, pest occurrences data, and satellite data products for the last six years.

Next Steps

- The project intends to proceed with the development of machine learning models for monitoring changes in land surface temperatures and soil surface moisture. This activity is ongoing, and the AI expert is undertaking this activity.
- The development of the PeMoST tool has commenced and so far the designs have been finalized. The back-end and front-end processes have started. The project team has organized a one-day workshop to develop and consolidate all the databases required for the PeMoST tool. This workshop is scheduled for the 12th of May 2023.
- The writing of one paper for publication is currently ongoing and a draft will be ready for review by the various team members from the 12th of May 2023. It is expected that the manuscript will be submitted for publication by the end of May 2023.
- It is anticipated that farm demonstrations for the training of farmers on the PeMoST tool will begin towards the end of June 2023 and proceed on for every season the crop will be grown by the Kathaana vegetable growers. Currently, the team is working on the relevant brochures and media material that will be required for the capacity building of Kathaana vegetable growers farmers.

Project 7: Empowering Smallholder Farmers (SHF) in Busia County using Low-Cost IoT (Internet of Things) and AI (Artificial Intelligence) Tools

Principal Investigator: Dr. Betsy Muriithi
Organization: Strathmore University, Kenya
Grant Amount: US$ 53,000.00 (US Dollar Fifty-three thousand only)
Grant Award Number: AFS-1465894639
Country of Implementation: Kenya.

Project Partners
Co-PI 1: Dr Joyce Malinga
Organization: Kenya Agricultural Livestock and Research Organization (KALRO)
Co-PI 2: Dr. Joseph Wabwire Masinde
Organization: Centre for Enterprising Communities (CECO), Kenya

Goal

The overall objective of the research is to provide localised and actionable gender-responsive climate information services to help rural smallholder farmers become climate resilient and increase yields and profits without risking the crops or live-stock from climate vagaries.

Objectives

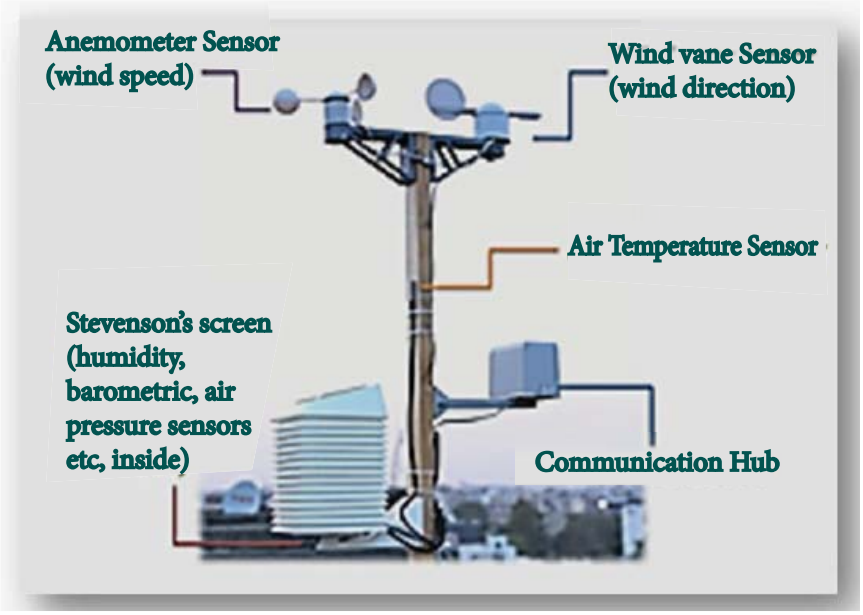
The specific objectives of the study are to:

- To take on a GEI lens in understanding specific stakeholder needs for climate information services related to weather, and climate in Kenya.
- To design and prototype 4 low-cost automatic weather stations using edge computing and IoT that will provide accurate daily/weekly forecasts and seasonal forecasts for smallholder crop farmers in Busia County.
- To design localised gender-responsive climate information services using the generated climate and weather predictions with agro-experts tailored to the needs of the stakeholders.

- To monitor and evaluate the use and effectiveness of information and climate services by rural smallholder farmers from a scaling perspective

Key activities

- Literature review of smallholder farmer access to climate information and its impact on production
- Stakeholder readiness assessment for low-cost smart weather stations report
- Assessment of capacity gaps and infrastructure needed for digital climate information services.
- Development of functional block diagram and software configuration including detailed hardware setting up.



Key Achievements

1. Through stakeholder engagement, we achieved alignment of the project objectives and the gaps felt by the smallholder farmers in the region in terms of climate information services. There was a consensus that the project objectives aligned with the activities taking place around climate-smart agriculture. The proposed technology also aligns with government plans on climate-smart agriculture focusing on improving agro-meteorological forecasting and monitoring and advisory services.

2. Smallholder farmer training and engagement- smallholder farmer engagement was a success primarily due to working with smallholder farmer groups actively working with the county climate-smart agriculture activities. The smallholder farmers were receptive to the project and could identify gaps that can be addressed.
3. Discovery of the youth owning smart mobile devices which informed on the of the delivery of the advisories. A mobile application was seen as the most ideal form of interfacing with farmers compared to USSD which has limited functionality.
4. Local Manufacturing - development of high-quality electronic devices at minimal cost through local Printed Circuit Board (PCB) manufacturing outlets. This substantially lowered the cost of production of one mini-weather station.

Next Steps

The current phase of the project involves the alignment of software and hardware elements to the specifications defined. The next step is the testing of the devices in the field. A two-stage testing phase will be conducted by deploying a sensor at the KARLOs farm laboratory as well as deploying the devices in selected farms in Busia County. There are several possibilities for scaling up our project to reach a larger number of smallholder farmers and have a broader impact. Some potential avenues for scaling up include geographic expansion that will replicate and expand our operations to other geographic areas with similar agricultural contexts and climate conditions. This would involve establishing partnerships with local organizations, governments, and farmer cooperatives to ensure effective implementation and sustainability. Partnering with existing farmer-facing organizations, such as cooperatives, agribusinesses, or agricultural extension services, can significantly enhance the scalability of our project. By integrating our weather and climate information services into their existing platforms or programs, we can leverage their networks and infrastructure to reach a larger number of smallholder farmers.

Project 8: Building the artificial intelligence (AI) for soil moisture and nutrient monitoring under irrigated agriculture among smallholder farmers, academic and agriculture experts in Malawi.

Principal Investigator: Dr. Isaac Fandika
Organization: Department of Agricultural Research Services, Malawi.
Grant Amount: US$ 54,000.00 (US Dollar Fifty-four thousand only)
Grant Award Number: AFS-4193755526
Country of Implementation: Malawi

Project Partners
Co-PI 1: Mr. Alinafe Emannuel Kaliwo
Organization: MECHRO Ltd, Malawi
Co-PI 2: Mr. Adam Rowland; Organization: SAHARA Ventures, Malawi

Goal

The overall goal for this project is to build artificial intelligence for soil moisture and nutrient monitoring under irrigated agriculture to improve food availability and stability being challenged by poor water and nutrient management among smallholder farmers and agriculture experts in Malawi.

Objectives

The specific objectives of the study are to:

- Improve water governance and water management at 30 irrigation schemes by commercially advancing irrigation management services using suitable digital technologies that are more efficient at a lower cost to the small-scale producer through a public-private partnership.
- Effectively empower one private sector service provider, five private data collectors, 30 public extension staff, and 60 lead farmers on how to install, maintain and interpret

AI tools (sensor) results for efficient water and nutrient management at 30 irrigation schemes in Malawi.

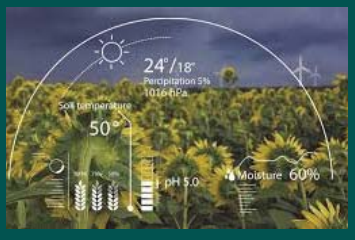
- Properly refine the data reporting system and data analytics, so that each sensor array installed and each measurement can be tracked to the individual farmer and the data collector.
- Effectively advocate farmer-friendly artificial intelligence use, commercialization and data management policy for agriculture and food system in Malawi.

Key activities

- Inception meeting and project planning.
- Mobilize and sensitize farmers and stakeholders on the project.
- Set-up and operate public private partnership for AI tools scaling.
- Acquire and deploy AI tool for soil moisture and nutrient monitoring under irrigated agriculture to enhance nutrient monitoring and use.
- Develop training manuals for the AI tool
- Training of end-user on the developed AI tool.

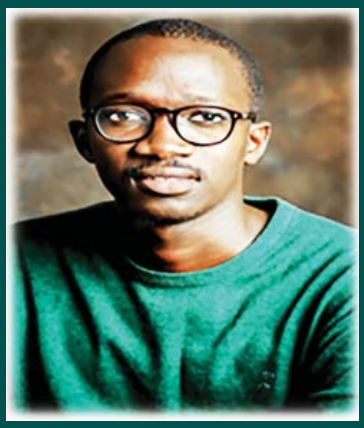
Key Achievements

- Setting-up an institutional framework for A.I. scaling to improve water governance and water management in the irrigation sector in Malawi. This has been achieved through mobilizing and sensitizing farmers at 30 irrigation schemes, engaging private sector and civil society on the application of AI for irrigation water and nutrient management in Malawi. This is important because farmers and stakeholder have been given knowledge about AI4AFS and will participate in applying their use in their respective schemes,
- Strengthened the capacity of farmers and partners on the use of A.I. tools (sensors) for improved irrigation and nutrient management in Malawi. Achieved by training a total of 86 farmers (37 male and 49 females in Chiradzulu) and 9 Staff in Chiradzulu district on the application of AI tools in agriculture and food system. This has been followed by acquisition of AI tools for the actual monitoring.
- Developed site and application to find the correlation of pair data parameters.



Next Steps

Project implementation started in the middle of irrigated farming season, and it is anticipated that this year, preparation, and eventual implementation will be on time, thus early on set of irrigation period. The project team plans to install sensors, conduct more data collection and visualization, as well as conducting advocacy on the AI tools and training in the districts of Mwanza, Neno, Blantyre, Chiradzulu, Phalombe, Mulanje, Chikwawa and Nsanje.



Project 9: TOLBI AI, an AI-based digital tool for smart, sustainable and efficient agriculture

Principal Investigator: Mouhamadou Kebe
Organization: TOLBI, Senegal
Grant Amount: US$ 48,000.00 (US Dollar Forty-eight thousand only)
Grant Award Number: AFS-5795725875
Country of Implementation: Senegal

Project Partners
Co-PI 1: Mouhamadou Moustapha Cissé
Organization: African institute for Mathematical Sciences, Senegal
Co-PI 2: Cheikh Ahmadou Bamba Fall
Organization: Yessal Agrihub, Senegal

Goal

The overall goal of the eTolbi AI project is to provide farmers, producers and public organizations with real-time yield forecasting information and a field management platform to monitor plant health, fertilization, and water requirements.

Objectives

The specific objectives of the study are to:

- Develop robust and scalable AI models for Senegal and for future deployments in other African countries.
- Increase production and income of farmers and women by 30% with more efficient field management based on eTolbi AI decision support tool to optimize agricultural inputs (fertilization) and better plant health management.
- Reduce post-harvest losses by 60-80% with an AI-based decision-making system and yield forecasts for producers and public organizations (+6M acre, 18 months, 6 seasons) in Senegal.

Key activities

- Development of the state-of-the-art in Yield Forecast model
- Local language data collected (agriculture limited domain)
- Design a system and Data architecture of TOLBI AI
- Implementation of the data and system architecture (Yield forecast L1(30m), L2(100m)) with the participation of Tolbi and AIMS teams Inception meeting and project planning.
- Data collection in the Google Cloud/AWS servers avec

Key Achievements

The project team were able to:

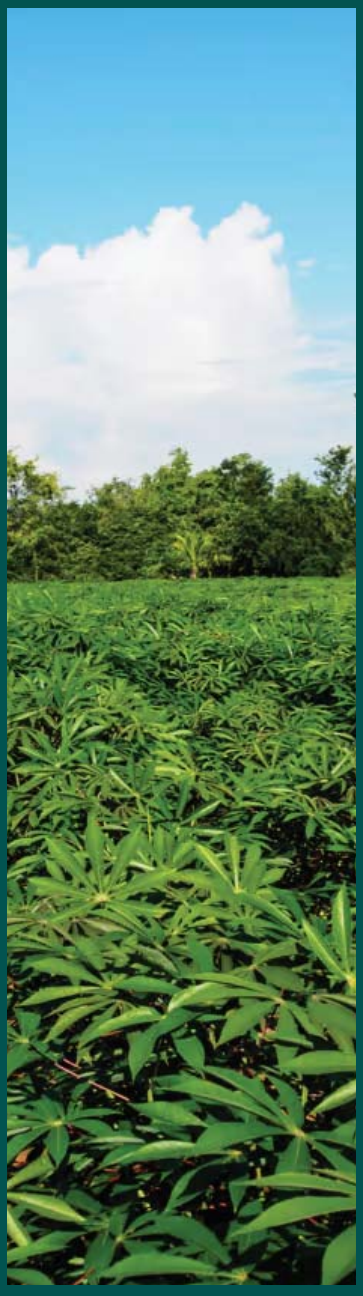
- The project implemented a new innovative methodology in the collection of spatial imagery data for precision agriculture called crop remote labelling which will eventually allow to automate the collection of high and low-resolution image data for practices such as classification, phenological modelling, monitoring of vegetation status. This will allow the industry and research institutions to have an innovative tool to accelerate the development of reliable solutions and their introduction on the market.
- Data collection in local language (limited to agriculture) have been carried out.
- Design of a new approach to collect high quality data to train the yield prediction model
- Design of a TOLBI AI system and data architecture.
- Developed state of the art yield forecasting model.
- Developed state of the art remote labelling data with satellite imagery

Next Steps

- Training and testing of the model with one or more iterations
- Integration of the models in a Geographic Information System
- Training and future users (Agent of the Horticulture Department) and maintenance of the system

Project 10: Title of Project: Detection of Crop Pests and Diseases on Web and Mobile Devices using Deep Learning

Principal Investigator: Dr. Patrick Kwabena Mensah,
University of Energy and Natural Resources, Sunyani, Ghana
Grant Amount: US$ 49,000.00 (US Dollar Forty-nine thousand only)
Grant Award Number: AFS-1233809296
Country of Implementation: Ghana



Project Partners
Co-PI 1: Mr. Suweidu Abdulai
Organization: Ghana Developing Communities Association, Ghana
Co-PI 2: Mr. Francis Ata Amponsah
Organization: DIGILECT SYSTEM, Ghana

Goal

The overall goal of the project is to develop a mobile/web AI-based system with which farmers can detect crop illnesses and pests in the early stages.

Objectives

The specific objectives of the study are to:

- Create a deep learning model to identify crop diseases and pests on a variety of Ghanaian crops specifically maize, tomato, cassava, and cashew.
- Deploy mobile and web-based applications for the identification of maize, tomato, cassava, and cashew pest and diseases.
- Communicate the pest and disease identified in the popular Ghanaian language; “Twi” through the mobile/web apps.
- Generate environmentally friendly recommendations such as pruning to control the disease/pest based on the stage of the infection using the mobile/web apps.

Key activities

The key activities for the first six (6) months where:

- Stakeholder feedback document.
- Raw pests and disease datasets, one dataset for each of 4 crops (cassava, maize, tomato, cashew).
- Labelled and annotated datasets for the four (4) crops
- Train deep learning (DL) models for each crop

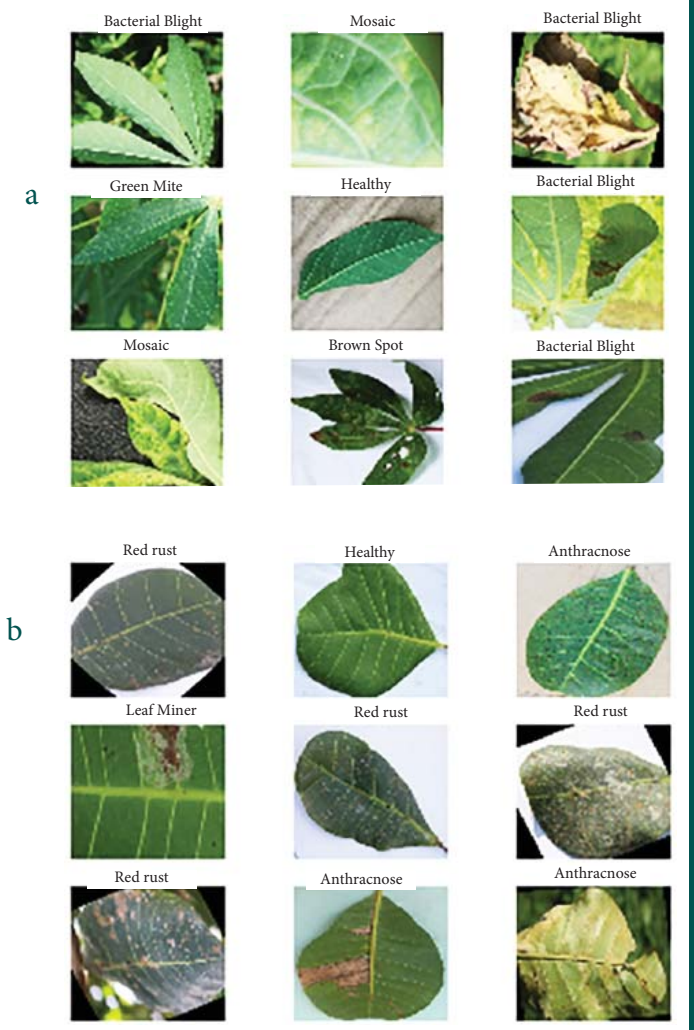
Key Achievements

The key projects achievements identified during the review of the progress report are as follows:
The project team were able to:

1. A successful stakeholder engagement: Stakeholders, especially farmers in smaller communities do not usually see the importance and contributions of some of the project activities to their profession. They usually prefer direct support in the form of cash handouts with most of them not educated enough to understand the benefits of the project activities. However, our activities during the stakeholder engagement and the data collection phases received massive support from the community members. This is a positive sign that the communities are willing to accept and adopt AI to improve their livelihood.
2. Local dataset: Data in Africa is scarce. Many AI applications from Africa depends on datasets collected outside of the continent. A successful collection of local datasets will help local AI models to generalize well based on the conditions in the study area.
3. Training of the deep learning models completed. The team have succeeded in training three deep learning models (one for each crop). The performance of the models, in terms of training, validation and tests accuracies are comparable the state-of-the-art models for the recognition of complex images.

Next Steps

The next phases of the project start with the development of tensorflow lite (TFLite) models from the existing Deep Learning models. These TFLite models will be deployed in the mobile app. The mobile and web app development process will also start in the next phase; however, the AI models will be used without conversion to TFLite models for the web app. Based on preliminary user requirements being gathered now, prototypes will be developed based on which the user requirements will be refined after this phase, paving the way for the actual deployment of the models to mobile and the web. This will give users the opportunity to detect their crop images using the mobile phone or the computer. A user manual will subsequently be developed, and the stakeholders identified during the initial stakeholder engagement will be trained to use the app effectively. We plan to pilot 5 e-kiosks in 5 communities to promote the adoption of the apps. The e-kiosk attendant will act as an immediate contact in the community and as an instructor to farmers who have difficulty in accessing/using the apps. Two more publications are expected to come out of the work in the next phase; thus, the models, their carbon footprint, how responsible they are in terms of AI, and the mobile and web apps.



Sample images from the augmented (a) cassava and (b) cashew datasets

We hope to raise the interests of the farmers in using the apps to enable us to increase the coverage to other crops such as garden eggs, yam, plantain, etc. We will seek support from the Ministry of Agric and non-governmental organizations to scale up the project. If this is successful, the number of e-kiosks will be increased, and farmers may be asked to contribute marginally to sustain the project.

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