Potential of agricultural technologies and innovations to overcome humanitarian challenges cause by climate change in West Africa

AICCRA Report

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Accelerating Impacts of CGIAR Climate Research for Africa

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About AICCRA Reports

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

Photos

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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 Association (IDA) of the World Bank. Explore our work at aiccra.cgiar.org

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ABSTRACT

The 14th edition of the biannual National Forum for Scientific and Technological Innovations (FRSIT 2023) organized by the Government of Burkina-Faso focused on "Humanitarian Challenges in Africa: Contribution of scientific research and innovation for sustainable solutions". The report documents the achievements and lessons learnt from CORAF's participation in FRSIT 2023. It also presents an analysis of how selected technologies and innovations generated by CORAF members that have the potential to prevent or overcome humanitarian challenges cause by climate change in West-Africa using the improved ALNAP's framework for evaluating humanitarian innovations. Two main activities were organized during the FRSIT: (i) Exhibition of technologies and innovations developed by the National Agricultural Research Systems (NARS) of CORAF and (ii) a Side-Event on "Potential of Technologies and Innovations generated by CORAF to meet climate change challenges, and strategies for making them available to users". Over 145 persons visited CORAF's stand with more than 50% willing to purchase some of the exposed technologies and innovations. On the other hand, more than 150 persons participated into the side-event. Ten technologies or innovations were presented, from which five were selected by the participants: (i) Improved FBT tomato varieties, (ii) Orange colored-fleshed sweet potato, (iii) Feed production processes based on mango residues, (iv) Cotton Particleboard and (v) Improved fish cages. All the technologies and innovations recorded a potential for preventing or overcoming more than 70%, with orange-colored fleshed sweet potato being the prominent technology, followed by improved cage fish and improved FBT tomato variety and finally the two remaining cotton particle-board and feed production processes based on mango residues. More than 93% of the participants showed their willingness to acquire at least one of these technologies for their activities.

CONTEXT AND JUSTIFICATION

A humanitarian challenge is a critical situation in which living conditions and basic needs of people are rapidly deteriorating, threatening their survival. Humanitarian crises can be triggered by armed conflict, natural disasters, pandemics, or extreme poverty. They have multifactorial causes and require in-depth analysis and understanding for effective actions. Humanitarian crises have devastating repercussions on the affected populations, directly affecting the lives of millions of people, with impacts on their health, safety, and survival.

During the last decade, the West African region registered several crises, with many that remained unsolved and thus, resulted to humanitarian crises. This situation seems not to be under control any soon due to the persistent socio-political context being registered in the region. Moreover, the expansion of terrorism activities (now from Sahel to coastal sub-region) give no hopes on establishing a peaceful condition to allow smallholder farmers and agricultural systems in general to continue feeding people. Humanitarian crises are triggered by protracted conflicts (armed or unarmed, ethno-socio-cultural) caused by unresolved or partially resolved socio-political situations, extreme poverty and famine, recurrent pandemics, and epidemics (Ebola, Lassa, COVID-19, etc.), ongoing crises in already highly vulnerable refugee camps, climate change, etc. As results, challenges caused by these humanitarian crises include security, health, food, nutrition, and education.

Climate change as a global phenomenon affecting living beings, including mankind and their ecosystems, is creating an unprecedented crisis. Indeed, extreme weather events, heat stress, declining air quality, changes in water quality and quantity, declining food security and safety, and changes in vector distribution and ecology are major threats to human (Romanello et al., 2021). The connection between climate change and conflicts leading to humanitarian crises is well established in the literature (Martin et al., 2014; Marzi, 2021; Agrawala et al., 2001; Läderach et al., 2021; Masood et al., 2022). The main challenges caused by climate change as a major humanitarian crise can be seen from different perspectives: (i) food and nutrition security, (ii) natural resource management: conflicts between farmers and herders, and (iii) migration.

Humanitarian crises are usually managed by supporting vulnerable and affected people. Unfortunately, climate change represents one of the key phenomena that has challenged this traditional humanitarian aid model, in that it is changing the nature and severity of humanitarian emergencies. Hence, it is obvious that climate change cannot be adequately managed using the traditional humanitarian aids, but by tackling the root-cause of the problem.

Over the past year, many coups d'état have taken place in Mali, Chad, Sudan, Burkina Faso, and Guinea, with some other failed attempts in the Central African Republic, Ethiopia, and Guinea-Bissau. Moreover, violent extremism has also spread due to (i) the political and economic marginalization of certain communities, (ii) the difficulties of democratic transition and the inability of governments to modernize their defense and security sectors mainly at local and country boundaries levels. Urgent and effective actions are needed to overcome these challenges, first in two main sectors: (i) security: overcoming violent extremisms and establishing peace in the affected places to (ii) ensure resumption and/or continuous sustainable foods production in face of climate change in those regions. The transitional Government of Burkina-Faso considers these two points as top priorities in their agenda. Hence, in search of effective

solutions, the government has turned to research and development and considered this as a hinge in the processus of recovering their territories and continues feeding their people.

Every two years the Government of Burkina Faso through its Ministry of Higher Education, Research, and Innovation and the Ministry of Industrial Development, Trade, Crafts and Small and Medium-sized Enterprises, organized the **National Forum for Scientific and Technological Innovations (FRSIT)**. The 14th edition (2023) of FRSIT focused on **"Humanitarian Challenges in Africa: Contribution of scientific research and innovation for sustainable solutions"**. CORAF provided technical and financial supports during this forum trough the AICCRA and TarsPro projects. Two main activities were organized by CORAF during this forum: (i) Exhibition of technologies and innovations developed by the National Agricultural Research Systems (NARS) of CORAF and **(ii)** a Side-Event **on "Potential of Technologies and Innovations generated by CORAF to meet climate change challenges, and strategies for making them available to users"**. This report presents the achievements of CORAF during FRSIT and analyses the potential of technologies and innovations presented by the NARS and Centers of Specialization during the event to overcome humanitarian challenges cause by climate change in West-Africa.

METHODOLOGY

The overall methodology (figure 1) used for this report comprises three main sessions: (i) exhibition of technologies and innovations during the FRSIT, (ii) organization of a side-event and (iii) analysis of the potential of these technologies and innovations to overcome humanitarian crises cause by climate change.

The report describes the two main activities (exhibition and side-event implemented by CORAF during FRSIT) by explaining how they were conducted. Critical observation and discourses analysis methods were used for collecting information. Details elements of methodology are given in sessions below.)

- **Exhibition:** A stand was prepared and managed every day of FRSIT by exposing projects, technologies and innovations developed by CORAF's network of NARS. Exposed elements were explained to each visitor. At the end of the visit, visitors were registered in a recording book as proof of their visit and to exchange contacts for either technologies purchasing or future collaboration.
- **Side-Event:** the side-event encompasses of two phases:

    - **Presentation of Technologies and innovations: representatives of one NARS:** Institut Togolais de Recherche Agricole (ITRA) and two Centers of Specialization: (i) Center of Aquaculture, led by the Agricultural Research Council of Nigeria and (ii) Center of Fruits and Vegetables, led by Institut de l'Environnement et de Recherches Agricoles (INERA) of Burkina Faso were invited to communicate on a maximum of five main technologies and innovations developed in their various centers and that can be used to overcome challenges cause by climate change in West-Africa. Finally, 10 technologies were presented: one from ITRA, four from center of fruits and vegetables and five from center of aquaculture.
    - **Pannel of discussion:** To contribute to the overall discussion of FRSIT 2023 based on its topic "Humanitarian Challenges in Africa: Contribution of scientific research and innovation for sustainable solutions", a panel of discussion was conducted on the topic "Potential of CORAF Technologies and Innovations to meet the challenges of climate change and strategies for

making them available to users". Eminent personalities in the field of agricultural development were invited as panelists. These were: (i) Dr Francois LOMPO, Director of Research, former Minister of Agriculture of Burkina Faso, (ii) Mr Marc GANSONRE, representative of farmers organizations at the Transitional National Assembly of Burkina Faso, (iii) Mr Inoussa OUEDRAOGO, agricultural entrepreneur, President of the Union national des sociétés coopératives des producteurs semenciers du Burkina Faso, (iv) Dr. Hamidou TAMBOURA, Research Director, Member of ANSAL/BF, former Minister of Animal Resources. Discourses analysis was used to collect major information from the speeches of these panelists as well as from the audience to which opportunity was given to share their views and thoughts on the topic.

- Analyses of the potential of agricultural technologies and innovations to overcome humanitarian crises cause by climate change: during the side-event, a survey was conducted to screen and prioritize technologies and innovations. Participants (over 100 individual interviews) were to give their overall impressions about the side-event and identified the five most important technologies and innovations (from the 10 presented), that they think it can be used to overcome climate change challenges, and later their willingness to purchase these technologies for their activities. A total of 104 participants were then interviewed. Our focus here remains to contribute to the overall discussion of the FRSIT 2023 topic "Humanitarian Challenges in Africa: Contribution of scientific research and innovation for sustainable solutions". Therefore, the five most selected technologies and innovations by the participants were screened against criteria used to evaluate humanitarian actions.

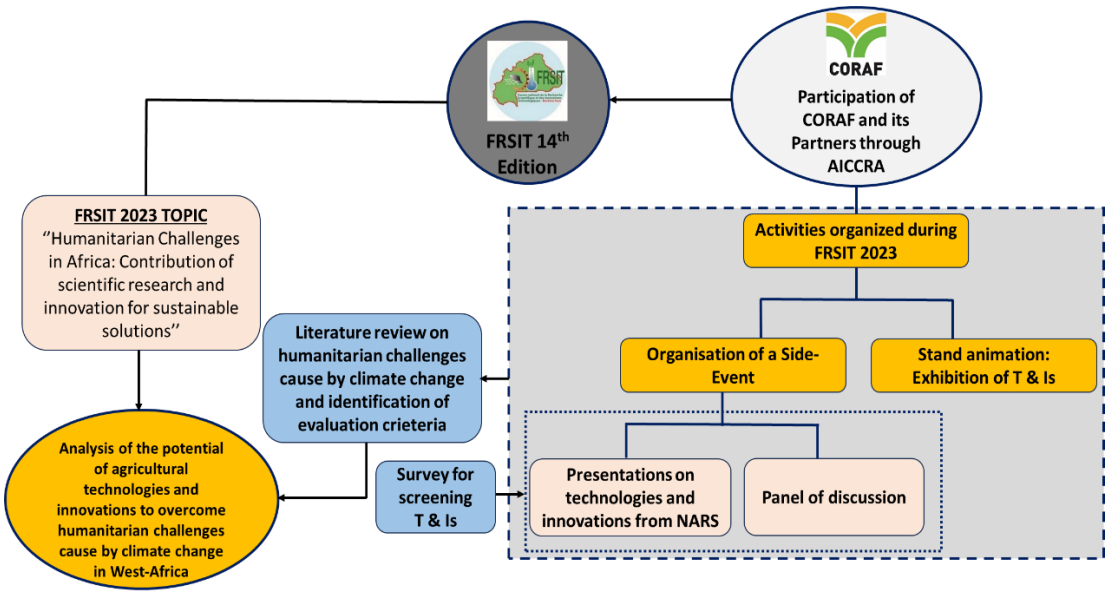

Figure 1: Overall methodological framework

Evaluation of humanitarian action (EHA) is a systematic and impartial examination of humanitarian actions intended to draw lessons to improve policy and practices to enhance accountability (ALNAP, 2006). EHA continues attracting donors, funding agencies, decision makers, researchers and technicians' commitment and attention (Darcy, 2003; Lawday et al., 2016; Abdelmagid et al., 2019) However, it has become now more efficient to think ahead and intervene based on forecasts and predictions before crises and disasters arise. Indeed, Anticipatory Action (AA) is an innovative approach to humanitarian action trough which risks and threats are analyzed and addressed

before an imminent crise, or disaster arises and causes damage to people. Hence, the importance for analyzing the potential of the selected technologies and innovations for (i) anticipating on any humanitarian crises that may arise due to climate change and (ii) addressing impacts of humanitarian crises cause by climate change. One of the most commonly framework (including criteria) used for evaluating humanitarian actions is the Guidance for Evaluation of Humanitarian Assistance in Complex Emergencies, developed in 1999 by the OECD's Development Assistance Committee (DAC) (Development Assistance Committee 1999). However, in 2006, ALNAP proposed a framework for interpreting the OECD-DAC criteria for better implementation (ALNAP 2006). Ten years later, Buchanan-Smith et al. (2016) updated these guidelines. In this study, we applied the improved version of the ALNAP' guidelines proposed by Obrecht (2017) for evaluating humanitarian innovation. Here, it must be clarified that the selected technologies and innovations (by the participants) are considered as "innovation". As defined by Obrecht (2017) in her paper discussing on the ALNAP' guidelines, the term "innovation" refers to a variety of practices emanating from a process and leading to a product. Therefore, humanitarian innovation can be a prototype of a product, process, position, or paradigm (Obrecht 2017). In this study, we only focused on products (technologies and innovations selected by the participants) as humanitarian innovation, and how they can be used to overcome humanitarian crises cause by climate change. Criteria used for the analysis are therefore adapted from those suggested by (Obrecht 2017) for a product/output (not the process) and presented in table 1.

Table 1: *Criteria for evaluating the potential of the technologies and practices*

Criteria	Definition	Brief explanation and questions to answer	Response scale
Do not harm	Taking precaution to minimize the potential harm caused to end-users and primary beneficiaries.	Were or would pilot end-users or immediate contacts be harmed by the innovation?	Yes = 0 or No = 1
Relevance and appropriateness	The extent to which the selected technology/innovation responds to a recognized problem or meets end-user needs and priorities. *Here, problems, needs or priorities are clearly related to climate change.*	- Does the technology/innovation address a clear need related to mitigation and/or adaptation to climate change? - To what extent did the technology / innovation meet that needs of its intended end-users and primary beneficiaries? - To what extent was the technology/ innovation accepted by the end users as meeting their climate change needs?	- Yes = 1 or No = 0 - Fully meet = 2, partially meet = 1, not meet = 0 -Fully=2, partially = 1, no = 0

		- Did the demand for the technology/ innovation come from primary end users, or from the innovating team?	- From users = 2, from needs assessment = 1 Only from researcher = 0
Efficiency and coverage	The rate at which inputs to the technology/innovation are converted into valued outputs and outcomes	- How is the input/output (or outcome) ratio of the technology/innovation compared to a current practices or approach? - At which scale the technology/innovation is planned to be used, or is being used?	- Higher = 2, equal = 1, lower = 0 - Higher scale = 2, lower scale = 1, Not scalable = 0
Effectiveness	- Learning: The degree to which the technology/ innovation is understandable or easily applicable and generates new knowledge or evidence for future improvement -Comparative Improvement: measurable, improvement, quality, or efficiency the technology/ innovation offers over current practices.	- How many humanitarians sector does the technology/ innovation contribute to overcome? - Is the technology/ innovation easily understandable or applicable by the end-users? - Does the technology/innovation offer a comparative improvement in the coverage, timeliness, relevance, connectedness, coherence, effectiveness and/or impact of humanitarian assistance? - Does the technology/innovation offer a better solution to the climate problem at stake that it seeks to address compared to current approaches?	- More than one = 2, one = 1, none = 0 -Easily = 2, required basics technicity = 1, required higher technicity = 0 - Yes = 1 or No = 0 - Yes = 1 or No = 0
Affordability	Cost of the technology/ innovation	-Is the technology/innovation affordable by the end-users compared to a current practice/approach?	- less cost (direct use) = 2, needs initial investment = 1, need higher initial as well as production investment = 0

Source: Adapted from Obrecht (2017): Evaluating humanitarian action using the OECD-DAC criteria An ALNAP guide for humanitarian agencies

To facilitate the analysis, response scale was uniformed throughout all the criteria with "fully accepted response" in green color and equals to 2 marks; "partially accepted" in yellow color and equals to 1 mark; and finally, "not accepted" response in red color and equals to zero.

KEY FINDINGS

Overview of FRSIT event and some outcomes

FRSIT has become a forum of great interest among national and international research institutions, innovators, and inventors, as well as technical and financial partners. It provides a suitable framework for reflection and discussion on major socio-economic development issues and opportunities, between research, invention/innovation, private/public sector and potential users of technologies and innovations. Thus, FRSIT creates a situation where successful solutions, ideas, technologies, and innovations are brought to the attention of potential users. FRSIT aims to promote convincing results from research as sustainable solutions to address challenges in our society in Burkina Faso and the West African sub-region. Ingredients of FRSIT are usually (i) technical and scientific sessions, (ii) exhibition of technologies and innovations, (iii) conferences and panels discussion, (iv) B to B meetings, (v) Incubation camp – Hackathon, (vi) short training workshops and (vii) awards ceremony. For this edition, four panels of discussion were organized: (i) the inaugural conference, the ministerial panel, the AATF and CORAF side-events. Highlights of the three first panels are presented in this section, while the CORAF's section is presented in sections below.

- Inaugural conference

The purpose of this inaugural session was to explain and initiate first discussions to clarify the central topic of FRSIT 2023 to participants. Two communications were presented, first by Prof. Alkassoum MAIGA and second by Dr Emmanuel NANEMA. These communications were followed by discussions and contributions from all the participants. Some of the solutions and recommendations made during the inaugural conference were:

- Investing in crisis preparedness, including training and local capacity building, can reduce the impact of disasters and improve community resilience.
- Beyond the immediate response, putting in place sustainable solutions that promote economic recovery, education and access to healthcare is essential to rebuilding affected communities.
- The use of technology, such as drones for aids delivery or artificial intelligence for data collection and analysis, can improve the effectiveness and efficiency of humanitarian operations.
- Promote the integration of ICT in education (from basics level), build the capacity of teacher-researchers, trainers and technical staff in new approaches and innovations, and constructing of new solutions, and innovative digital educational content, create secure technological platforms for training and research, deliver innovative training and research in the fields of health, agriculture, and the value chain.
- Improve collaboration and sharing of information between humanitarian organizations, governments and stakeholders is essential to avoid duplication and ensure an effective response to crises.

- Involving local communities in the planning and implementation of humanitarian interventions enhances the relevance and effectiveness of efforts.

- Ministerial panel

This panel focused on *"Financing research and innovation in a context of security and humanitarian crisis*" and stands as opportunity to revisit funding mechanisms for research and development in West Africa since the 1st edition of FRSIT in 1995 till now. Indeed, research funding has been always at the heart of discussions, mainly because recommendations may not be satisfactorily implemented, while stakeholders and policy makers all agree on the importance of research for sustainable development because it provides solutions and technologies. However, the question remains: why are results from research are little known in both the private and public sectors? Why are financial resources provided to research are limited?

Some indicators justifying these questions in Burkina Faso and beyond are:

- Low allocation of financial resources: Burkina Faso is committed to allocate 1% of its national budget to research. In practice, it is less than 1%;
- Research environment: Lack of appropriate research infrastructures and equipment;
- Low researcher/population ratio: Less than 100 researchers per million inhabitants.

Discussions reveled that one of the reasons justifying this situation may be the fact that many countries in the Sahel region are in a context of war against terrorists trying to extend their territories and take over government. Hence, in addition to all the other known causes of lack of fundings for research in West-Africa, funding security has become a priority for many countries. For example, in Burkina-Faso, around 15-20% of the national budget is spent on security.

Some of the solutions and recommendations made are:

- Improving strategies for mobilizing more funds from private sector,
- Training researchers on external (international) financial resources mobilization,
- Organization of hackathons and incubations for those with non-matured projects and/or prototypes without license or patent,
- Supporting the organization of intellectual property rights days for researchers and inventors,
- Formalizing research programs for greater synergy.

- The AATF' side event

The African Agricultural Technology Foundation organized a side-event on the theme "The role of modern biotechnologies in transforming African agriculture in a context of climate change: AATF's contributions and achievements". Two communications were presented, first by Dr Moussa SWAVADOGO on "sharing the vision of African Union on Technological Innovations and ongoing initiatives", and second by Dr Oumar TRAORE on "application of modern biotechnologies in the agro-sylvo-pastoral sector: current situation and regulations". These communications were followed by discussions and contributions from all the participants. Some of the solutions and recommendations made to improve the use of biotechnologies in agriculture were:

- Advocate for the return of BT cotton in Burkina Faso and beyond, given the many advantages it offers, while ensuring that the entire process is under control;
- Investigate the possibility and feasibility for introducing the Kenyan maize varieties recognized for their resistance to drought, given the increasingly drastic climatic hazards;
- Create a fund for biotechnology research and food security (with a percentage levy on exported products) to boost research activities;
- Take appropriate measures to counter the misleading and often unfounded information circulating on social media, which undermines the efforts of researchers on opportunities provided by biotechnology.

Exhibition of technologies and innovations during FRSIT: presentation and outcomes from the CORAF's stand

During FRSIT 2023 a stand was prepared and managed by CORAF to show case of efforts and solutions proposed by CORAF and partners (figure 2). Ongoing projects being implemented by CORAF, and its partners were exposed using printed short pamphlet describing (i) the Project Development Objective (PDO), (ii) the key achievements so far and expected results, (iii) the ongoing activities as well as the implementing partners. Technology and innovation cards were also used and shared to each visitor. Technology/innovation card is a sort of visiting card giving vital information about the technology/innovation and important links where details others information can be found. About 145 persons visited CORAF's stand with more than 50% of them willing to purchase some of the exposed technologies and innovations for their business.

Figure 2: Participants visiting CORAF's stand at FRSIT

CORAF's side-event

Categorization of participants

More than 150 persons participated to the side-event, with about 105 who accepted to take part of our survey. This latest group came from six different countries of West-Africa: Burkina Faso, Benin, Chad, Mali, Niger, Togo (figure 3). Majority of the participants (88%) came from Burkina-Faso because the event was held in the country. Among the participants, 44% were women while 55% were men. Majority of the participants were student from technical universities or technical high schools (73%), followed by researchers/inventors (figure 4).

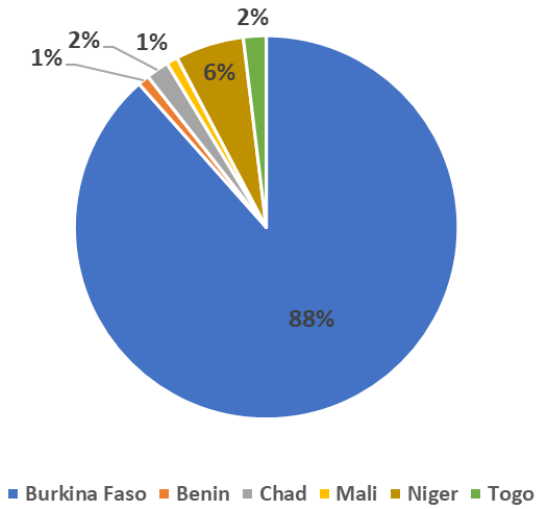

Figure 3: Nationality of the participants

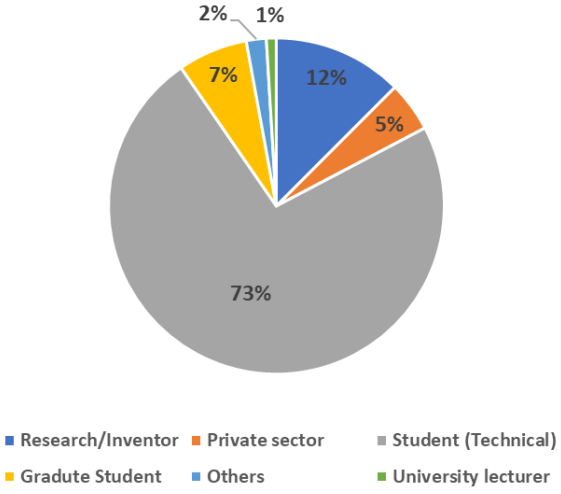

Figure 4: Domaine of activity of the participants

Panel of discussion

The purpose for initiating this discussion around the topic "Potential of CORAF' technologies and innovations to meet the challenges of climate change and strategies for making them available to users" was (i) to share mechanisms and efforts from CORAF and partners for disseminating agricultural technologies and innovations, (ii) to find new solutions and ideas for improving the scaling-up mechanisms in the context of humanitarian crises. To arrive at these objectives, four panelists were invited for the discussion:

- Dr Francois LOMPO, Director of Research, former Minister of Agriculture of Burkina Faso,
- Mr Marc GANSONRE, representative of farmers organizations at the Transitional National Assembly of Burkina Faso,
- Mr Inoussa OUEDRAOGO, agricultural entrepreneur, President of the Union national des sociétés coopératives des producteurs semenciers du Burkina Faso,
- Dr. Hamidou TAMBOURA, Director of Research, Member of ANSAL/BF, former Minister of Animal Resources.

The discussion was moderated by Dr Kyky Komla GANYO and reporting was done by Dr. G. Esaie KPADONOU, both from AICCRA/CORAF.

The first question to the panelists was "what are the major issues and challenges involved in making technologies accessible to users?" After discussion, conclusion was drawn in line with the main challenge

of security and democracies that require us to produce more to feed the growing population. This role, research, and development must continue playing it, and even speed-up the processes for generating technologies and innovations to meet this challenge. After that, innovation platforms, as well as the national agricultural advisory and extension system must take over by providing suitable training and supports to farmers who in turn will produce more to ensure food security in our region. A follow-up question was addressed to the panelists as follow: "beside security and democracy challenges, what other issues need to be considered?". Discussions on this question concluded that one of the major factors that must be considered is the massive displacement of people and animals, which puts a strain on labor capital. Additionally, most agri-inputs markets have been de-structured, contributing to the unavailability of these important products, hence unbalancing of prices. Therefore, innovations and technologies development need to also focus on adaptation of changing economy.

To deepen the discussion, second question addressed to the panelists was: "what are the problems associated with technology adoption by farmers?". Panelists acknowledge efforts made by research to develop technologies and innovations. However, they emphasized on the fact that most of these technologies are not accessible to farmers, and that it is great time to move from discourses to take more actions on making technologies available to farmers. The main cause of this situation is the fact that many of these technologies are not fully adapted to farmer's needs. Types of agricultural systems in sub-Sahara Africa must be considered: (i) familial farming for subsistence and (ii) the emerging agro-businessmen. Consequently, development of technologies and innovations must consider these types of farming systems. Besides, technologies made available based on local specificities (weather, pedology, etc.), socio-cultural context and be accessible both technically and economically. Another challenge is the emergence of new diseases and pests for which specific solutions must be found.

Question related to the successful dissemination of technologies and innovations was: "do regulations allow technologies to be disseminated?". As response, panelists acknowledge the existing of laws and regulation n agricultural sector in general and food systems. However, there is a clear problem of coherence between them and mainly about their adoption. Panelists insisted on the fact that there is often a lack of willingness for the implementation of certain laws, while others lack accompanying measures treating the successful initiation and implementation of policies. The hope remains in the scaling and use of adequate technologies and innovations to avoid or overcome humanitarian crises.

Presentation and description of technologies and innovations presented at FRSIT 2023

After the opening ceremony of the side-event, the 10 technologies and innovations were presented: one from ITRA, four from center of fruits and vegetables and five from center of aquaculture (figure 5). Characteristics and performances of these technologies and innovations are presented in table 1.

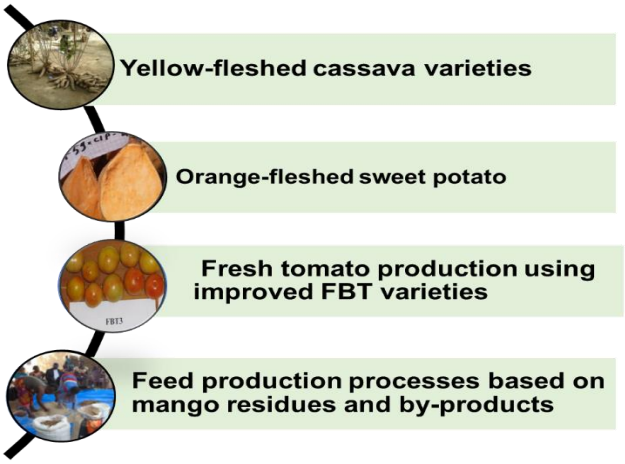

Figure 5a: *Technologies and innovations presented by regional center of Excellence on Fruits and vegetables*

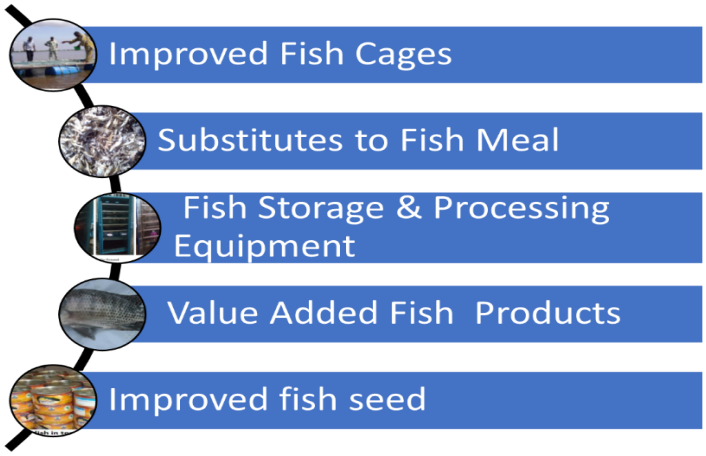

Figure 5b: *Technologies and innovations presented by center of aquaculture*

Figure 5c: *Technologies and innovations presented by ITRA*

Table 2a: *Description of technologies and innovations on aquaculture*

Name of the technology/ innovation	Brief description	Technical Performances	Current state of use	Cost and benefits	Photo
Improved fish cages	Fish cages installed in water bodies, stocked with desirable fish for culture and the fish is fed for a period of 4 months to 5 months before harvest	High stoking density, low cost of operation, Environmentally and gender friendly	Already being used by coastal fish farmers	Ranges from 560 to 3500 USD. contributes to sustainable fish production	

Low-cost fish feed and fish meal (Cassava based feed, Fish meal)	Developed from Clupeid, Lantern, trash tilapia and cassava leaves, they are substitutes to imported fish meals.	Very nutritious and made from local ingredients.	Adopted by fish farmers with contribution from feed millers	Ranges from 0.75 to 1.25 USD/kg Reduce cost of production and increased profit	
Improved Fish Storage and Processing Equipment	These are technologies like smoking Kiln, Ice Fish Box, solar tent, fish retail table, etc. to be used for smoking or drying fish in an efficient way to meet regional demands and international export standards	Fast smoking potential. Portable, hygienic oil collector, gender friendly, High quality smoked fish	Adopted by fabricators, fish farmers and possessors	Ranges from 2 to 1900 USD. Reduced environmental pollution and post-harvest losses.	
Improved fish seed	Selected species of proven characteristics induced and bred for improved offsprings. Some of them are *Clarias gariepinus*, Heterobranchus species, *Oreochromis niloticus*, wesafu, *Chrysichthys nigrodigitatus*, *Tarpon atlanticus*, *Penaeus monodon*, *Macrobrachium vollenhovenii*.	Fast growth, sizable tilapia for table consumption, quick turnover	Already disseminated to farmers	< 1 USD per fingerling. Increased fish production and diversity	
Fish Value Added Products	Value addition to low-priced small and medium-size: canned Catfish, Tilapia and Ariomma bondi	Increasing value and utilization of fish. Good for school-age children	Already in the market	0.44 USD/can. Investment and job opportunities, product diversification, reduced fish importation, improved nutrition and hygiene, high aesthetic value.	 Canned catfish in tomato sauce

Table 2b: Description of technologies and innovations on fruits and vegetables

Name of the technology/ innovation	Brief description	Technical Performances	Current state of use	Cost and benefits	Photo
Yellow-fleshed cassava varieties	Cassava with yellow colored flesh, used by human for food with high health impact due to high beta-carotene (Vit A) content - Resistant to African Cassava Mosaic (ACM)	30-40 T/ha Short production cycle: 12 months.	Largely used for making Gari, Atiéké, porridge, etc.	Benefit of 1400 1500 USD/ ha High processing potential.	
Orange colored-fleshed sweet potato	Sweet potato, with orange colored flesh, used by human for food with high health impact due to high beta-carotene (Vit-A) content.	20-25 T/ha, in 3 to 4 months of production	Widely use as ditches, infant flours, chips, juices, couscous, etc.	Benefit of 1500 USD/ha after 4 months.	
Fresh tomato production using improved FBT varieties	Tomato variety adapted to drought and dry spells conditions. Widely used in human ditches.	25-32 T/ha, Short production cycle: 2.5 - 3 months.	Poor diffusion due to the lack of accredited seed companies	Benefit of 1600 USD/ha after 4 months	
Feed production processes based on mango residues and by-products	Production of livestock feed in small and semi-mechanized units - Sanitation of processing units	4 T/day (5 working hours per day) of mango crush for 2 T of feed produced.	Waiting for partners to reproduce the machine in series.	6115 USD/Unit + 2000 USD CV/month	 

Table 2c: *c: Description of technologies and innovations from ITRA*

Name of the technology/ innovation	Brief description	Technical Performances	Current state of use	Cost and benefits	Photo
Particle-board	Technology for manufacturing particleboard from cotton stalks. Cotton-made particle-boards are used in carpentry	Total number of particleboard (30x30cm) manufactured from 1000 kg of cotton stalk is 1000 for 9 mm thickness formats, 800 for 12 mm	Pilot project completed in Benin, Mali, and Togo	N/A	

	and other wood works.	formats and 500 for 18 mm formats.			

These technologies and innovations were screened by participants during the survey. From the survey, the five most selected technologies were: (i) Improved FBT tomato varieties, (ii) Orange colored-fleshed sweet potato, (iii) Feed production processes based on mango residues, (iv) Cotton Particle-board and (v) Improved fish cages (table 3).

Table 3: Ranking of the technologies and innovations by the participants

Technologies and innovations	Rank 1 (%)	Rank 2 (%)	Rank 3 (%)	Rank 4 (%)	Rank 5 (%)
Improved fish cages	9	11	6	9	17
Low-cost fish feed/meal	4	1	3	11	6
Improved Fish Storage and Processing	1	7	12	4	11
Improved fish seed	3	1	5	7	6
Fish Value Added Products	1	2	8	7	11
Yellow-fleshed cassava varieties	17	12	12	2	11
Orange colored-fleshed sweet potato	19	20	9	11	6
Improved FBT tomato varieties	25	22	18	9	6
Feed production processes based on mango residues	14	13	15	27	6
Particle-board	6	10	11	13	22

Note: cells in green color represented the final selected technologies/innovations and cells in blue color represent technologies ranked first.

Analysis of the potential of technologies and innovations to overcome humanitarian challenges caused by climate change

Humanitarian crises can threat and cause damages to four main sectors security-peace, health, food-nutrition, education, and earth system threats. Similarly, climate change can also affect these sectors, with consequences leading to unprecedented humanitarian problems when it is partially or not solved. Prevention seems to be the ultimate efficient response in such situation. The five selected technologies and innovations and presented in table 4 have the potential at different levels to prevent and overcome humanitarian crises related to climate change. The analysis revealed that all the five technologies have the potential for overcoming or prevent humanitarian crisis related to climate change (table 4). They all recorded a potential more than 70%, with orange-colored fleshed sweet potato being the prominent technology, followed by improved cage fish and improved FBT tomato variety and finally the two remaining cotton particle-board and feed production processes based on mango residues (figure 6). These results corroborate with the responses to the question asked to participants weather they are

willing to purchase these technologies to improving their ongoing and/or future business. More than 93% of the participants showed their willingness to acquire at least one of these technologies in their activities.

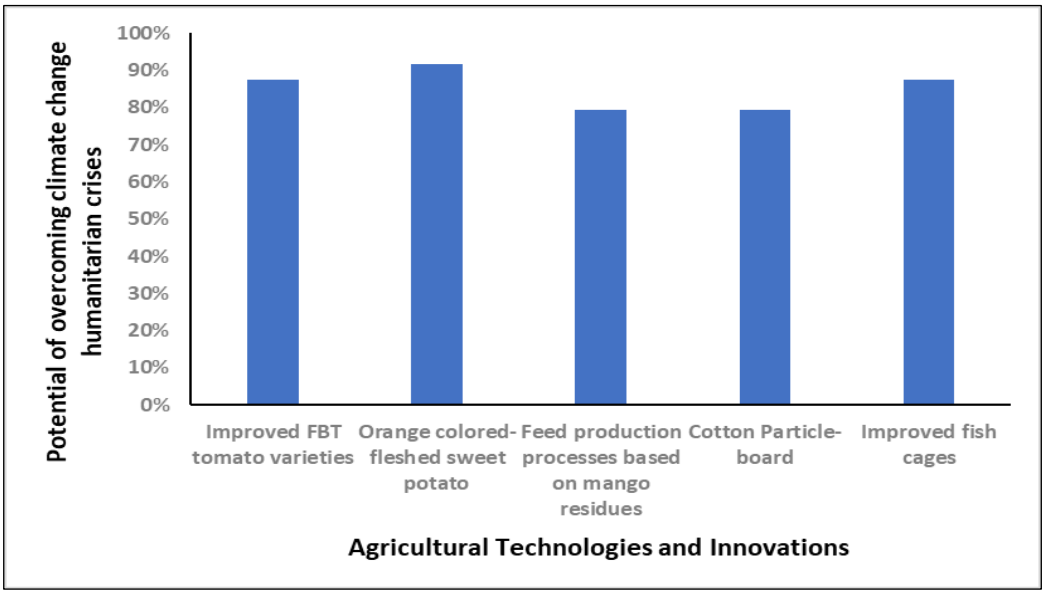

Figure 6: *Potentials of the agricultural technologies and practices for overcoming or preventing humanitarian crises cause by climate change*

Table 4: Potentials of the agricultural technologies and practices for overcoming or preventing humanitarian crises cause by climate change

Technologies / Criteria	Improved FBT tomato varieties	Orange colored-fleshed sweet potato	Feed production processes based on mango residues	Cotton Particle-board	Improved fish cages
Were or would pilot end-users or immediate contacts be harmed by the innovation?	No Except in case of intoxication during cultivation	No Except in case of intoxication during cultivation	No Except in case of intoxication during processing	No	No
Does the technology/innovation address a clear need related to mitigation and/or adaptation to climate change?	Yes FBT is highly adapted to drought and dry spells conditions	Yes High health impact due to high beta-carotene (Vit-A) content. Can be used to overcome climate born new diseases.	Yes Production of livestock feed in quality and quantity can contribute to avoid hunger and boost animals' productivity.	Yes The use of cotton residues for making particle board significantly decrease pressure on forests and wood resources.	Yes Fish cages installed in water bodies help to avoid water scarcity and drought that treat fisheries and boost the production
To what extent did the technology / innovation meet that needs of its	Fully meet Because the technology what	Fully meet Because the technology what	Fully meet Because the technology what	Fully meet Because the technology what selected	Fully meet Because the technology what

intended end-users and primary beneficiaries?	selected by the potential users	selected by the potential users	selected by the potential users	by the potential users	selected by the potential users
To what extent was the technology/ innovation accepted by the end users as meeting their climate change needs?	Partially accepted Poor diffusion due to the lack of accredited seed companies. Dissemination process still ongoing.	Fully accepted Widely use as ditches, infant flours, chips, juices, couscous, etc.	Partially accepted Waiting for partners to reproduce the machine in series.	Not yet Pilot project completed in Benin, Mali, and Togo	Fully accepted Already being used by coastal fish farmers
Did the demand for the technology/ innovation come from primary end users, or from the innovating team?	From needs assessment Based on specific need of adaptation to drought and dry spells	From needs assessment Based on specific need of improving productivity and nutrition	From needs assessment Based on market analysis related to the availability of feedings for animals	From needs assessment Based on need assessment to replace forest wood by other materials	From users Mastering water management in fish production needed appropriate technology
How is the input/output (or outcome) ratio of the technology/innovation compared to a current practices or approach?	Higher Requires less inputs and produces higher outputs	Higher Requires less inputs and produces higher outputs	Higher Requires less inputs and produces higher outputs	Higher Requires less inputs and produces higher outputs	Higher Requires less inputs and produces higher outputs
At which scale the technology/innovation is planned to be used, or is being used?	Higher scale Diffusion still ongoing and technology planned to be largely adopted	Higher scale Diffusion still ongoing and technology planned to be largely adopted	Higher scale Diffusion still ongoing and technology planned to be largely adopted	Higher scale Diffusion still ongoing and technology planned to be largely adopted	Higher scale Diffusion still ongoing and technology planned to be largely adopted
How many humanitarians sector does the technology/ innovation contribute to overcome?	One Food and nutrition	One Food and nutrition	One Food and nutrition	One Decreases threats related to earth system unbalance	One Food and nutrition
Is the technology/ innovation easily understandable or applicable by the end-users?	Easily applicable Seeds to be sown	Easily applicable Seeds to be sown	Required basics technicity Need to understand how to operate and maintain the machine	Easily applicable Particle-board ready to be used	Required basics technicity Need to understand how to maintain cages
Does the technology/innovation offer a comparative improvement in the	Yes Can be used to prevent humanitarian crises	Yes Can be used to prevent humanitarian	Yes Can be used to prevent humanitarian	Yes Can be used to prevent humanitarian	Yes Can be used to prevent humanitarian

coverage, timeliness, relevance, connectedness, coherence, effectiveness and/or impact of humanitarian assistance?	and/or to recover from them in humanitarian camps or beyond	crises and/or to recover from them in humanitarian camps or beyond	crises and/or to recover from them in humanitarian camps or beyond. Animals' feeds produce can be used to speed-up animal rearing in humanitarian camps.	crises and/or to recover from them in humanitarian camps or beyond. Tables, chairs and others wood materials to be used in humanitarian camps can be made using cotton particle-boards	crises and/or to recover from them in humanitarian camps or beyond
Does the technology/innovation offer a better solution to the climate problem at stake that it seeks to address compared to current approaches?	Yes FBT is highly adapted to drought and dry spells conditions	Yes High health impact due to high beta-carotene (Vit-A) content. Can be used to overcome climate born new diseases.	Yes Production of livestock feed in quality and quantity can contribute to avoid hunger and boost animals' productivity.	Yes The use of cotton residues for making particle board significantly decrease pressure on forests and wood resources.	Yes Fish cages installed in water bodies help to avoid water scarcity and drought that treat fisheries and boost the production
Is the technology/innovation affordable by the end-users compared to a current practice/approach?	Less cost (direct use) Purchase of seeds	Less cost (direct use) Purchase of seeds	Needs initial investment Initial investment in affording the machine	Needs initial investment Initial investment in affording the machine	Needs initial investment Initial investment in affording the machine

Note: green = 2 marks; yellow = 1 marks and red = 0

CONCLUSION

Humanitarian challenges cause by climate change in agricultural sector can be prevented or overcome using technologies and innovations. The 14th edition of FRSIT demonstrated that research is still the corner stone even in humanitarian or war conditions. CORAF and its partners proposed a range of technologies and innovations from its NARS that were presented in form of exhibition in a stand during the FRSIT. Ten technologies and innovations were presented during a side-event organized by CORAF and its partners. Among these, the five most selected were: (i) Improved FBT tomato varieties, (ii) Orange colored-fleshed sweet potato, (iii) Feed production processes based on mango residues, (iv) Cotton Particle-board and (v) Improved fish cages. These technologies and innovations were analyzed with the lens of ALNAP improved criteria for evaluating humanitarian innovations. This analysis showed that all the five technologies recorded a potential for preventing or overcoming more than 70%, with orange-

colored fleshed sweet potato being the prominent technology, followed by improved cage fish and improved FBT tomato variety. More than 93% of the participants showed their willingness to acquire at least one of these technologies for their activities.

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