Article

Transforming Extension and Service Delivery through Bottom-Up Climate Resilient Farmer Field School Approach to Agribusiness in Eastern Africa

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Abstract

There is consensus that climate variability and change is impacting food security in Eastern Africa, and that conventional extension approaches, based on top-down model of information dissemination and technology transfer, are too inadequate to help smallholder farmers tackle increasingly complex agro-climatic adversities. Innovative service delivery options exist but are mostly operated in silos with little effort to explore and blend them. There are efforts to develop a blended Climate-Resilient Farmers Field School methodology to address the gaps, with objective to improve participants' knowledge, skills and attitude to apply the blended approach and to sensitize actors on what needs to be advocated at the policy level. Some 661 local trainers/facilitators (ToT/ToFs), 32% of them women and 54% youth, were trained across Kenya, Tanzania, and Uganda, with additional 76 Master Trainers (MToTs) trained to backstop the ToT/ToFs. Through the implementation, the process reached 36 agribusinesses covering some 237,250 smallholder farmers trained across Kenya, Tanzania, and Uganda on CSA technologies, practices, and innovations by the end of 2020. The blended approach offers lessons to transform extension to help farmers improve food security and resilience. Preliminary findings indicate that the process is rapidly shaping individual adaptive behavior and group adaptive thinking. Lessons also show a strong need for agronomists to work more closely with agro-meteorologists to ensure that farmers are properly guided to participate appropriately in the co-generation and application of climate information and agro-weather advisories, which they can interpret easily and utilize for their agricultural production purposes. Experience from this initiative can be leveraged to develop scalable participatory extension and training models.

Keywords: participatory methodologies; policy, advocacy; agronomy; information/ variability; agro-weather advisories.

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1. Introduction

Climate change has been proven to adversely impact agricultural production, food systems and food security in East Africa. The need to increase agricultural productivity and improve agribusiness resilience on the backdrop of increased climate variability in the region calls for adoption of more climate resilient, ecologically sustainable methods of agricultural production. This call requires concerted efforts and joint investments by agricultural supply chain actors and partners in various agribusiness value chains to support transformational change in service delivery. Actionable climate information is critical for such a transformation [1,2]. However, currently, and especially due to the challenges of climatic "new normal" [3], most smallholder farmers are not receiving actionable climate information for effective decision making.

A field school is a group-based extension concept based on the principles of adult learning. Field school methodology is a pro-adaptation strategy used to promote adaptation practices through social learning and capacity building initiatives [4]. Farmer Field School (FFS) is a group-based bottom-up experiential learning methodology grounded in the principles of adult education [5–7]. FFS was initiated and driven by the Food and Agriculture Organization (FAO) of the United Nations (UN) through national ministries in charge of agriculture [8]. The main objective of FFS was to build common knowledge, jointly with smallholder farmers/users of the knowledge, for integrated production and pest management (IPPM) in a more sustainable way than the agro-chemical/pesticide approaches. Climate Field School (CFS) was initiated and driven by the Global Framework for Climate Services (GFCS) Programme of the World Meteorological Organization (WMO), through the National Hydro-Meteorological Services – NHMS [9]. The objectives of the CFS were to increase smallholder farmers' knowledge about climatological processes, to increase farmers' ability to anticipate extreme events in their agricultural planning, to improve farmers' capacities to observe climate variables, and to facilitate farmers' use of formal climate information in conjunction with their own experiences and knowledge in their management decisions [10]. After following the program, farmers were expected to apply the climate information in setting up alternative crop management strategies [11]. Key features of similarity in the two approaches include season-long learning activities (per the seasonal cycles); learning or study/ experimental plots to compare technologies and practices; facilitation to guide the learning; and regular meetings/ sessions during the season. Each session includes agroecosystem/ agrometeorological analysis (AESA/ AGROMETA); a group dynamics exercise; a special topic and feedback on the session.

The gap

Much as FFS and CFS have similarities, they also have differences, which create silos in implementation of the approaches. On the surface, CFS looks similar to FFS, but the details of the CFS content reveal a fundamentally different approach [11]. The CFS approach strongly assumes smallholder farmers' ability to interpret scientific data, or to comprehend analytical approaches and agro-advisories disseminated by scientific institutions. WMO promotes Climate Field School (CFS) approach as a good practice solution based on FAO's Farmer Field School (FFS) Model but the two are still operated in separate silos [11]. Although understanding weather forecasts could in theory be helpful to farmers, notedly activities that identify, enhance, and build on farmers' knowledge, capacities, and institutional processes is given lower priority by CFS practitioners, a practice which represents a major departure from the original premise of FFS. CFS works in favour of conventional top-down models of extension service delivery, a style which creates barriers to optimization of the CFS-FFS synergy [12].

In principle CFS was patterned on the FFS concept, but in practice the implementation did not live up to the FFS expectation, a deeply farmer-driven approach to climate change adaptation [10,13]. Two examples of steps in running an FFS (Figure 1) and running a CFS (Figure 2) serve to illustrate the differences. Whereas FFS is practically cyclic and iterative, CFS is linear and unidirectional. In the CFS case, the middle level agriculture officers are trained by meteorologists to understand climate concepts, interpret climate forecasts, and ways of integrating them in agricultural activities. Then the middle level agriculture officers train local level extension workers. Finally, the local level extension workers conduct dialogues with farmers in meetings to "reinforce" farmer perceptions on climate patterns through the use of climate data and information [13]. Forecast reports are used in discussions at middle levels to provide agro-advisories for the season. The agro-advisories are then transferred down the chain of command to farmer groups at the local level. Key features of differences between Farmer Fields Schools and Climate Field Schools are presented in Table 1.

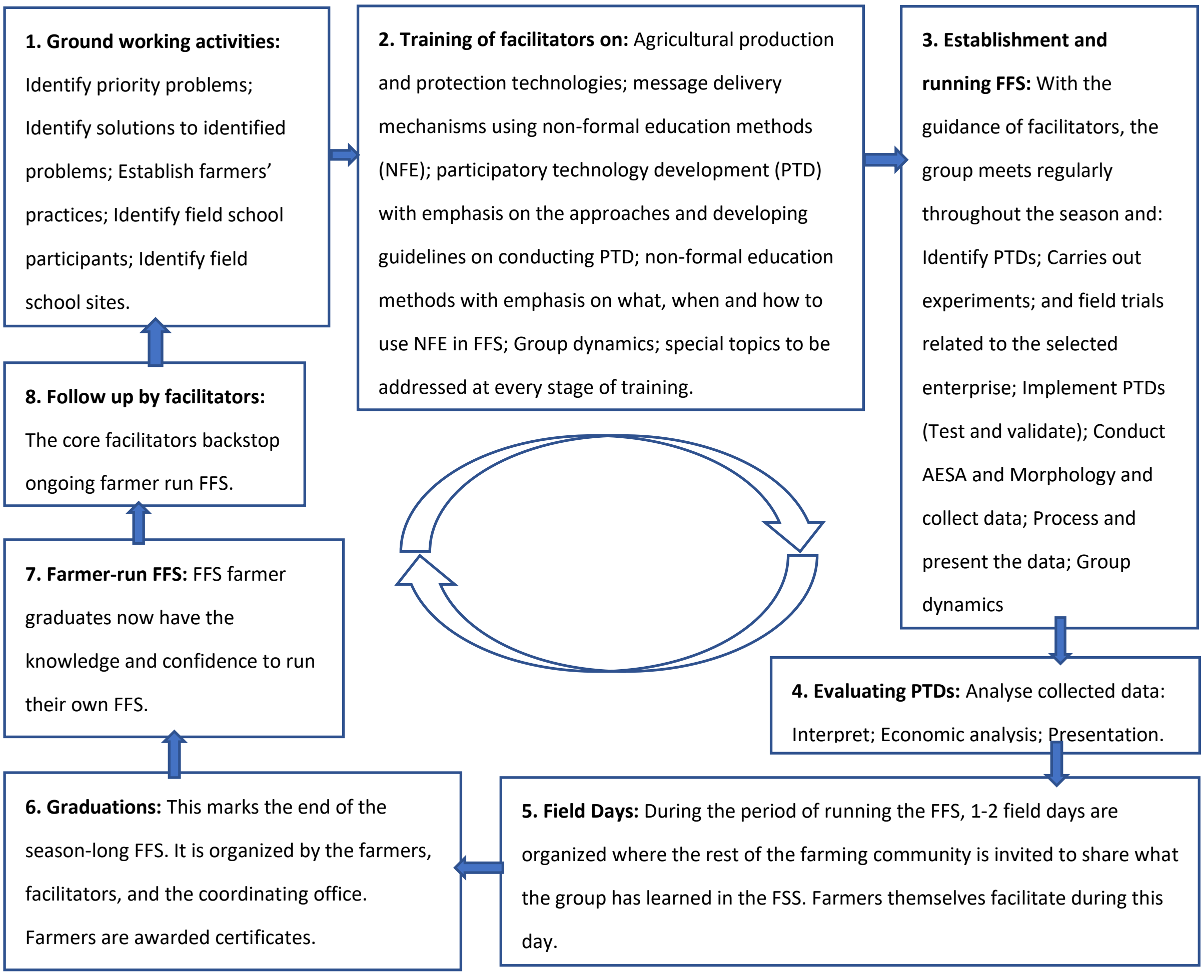

Figure 1: Steps in running an FFS in Eastern Africa, with farmers brought on board at very early stages, and a farmer empowerment to take charge. Source [14]

Instead of mirroring FFS, CFS ended up emphasizing more of dissemination, technology transfer and agro-weather advisories (prescriptions on farm practices) than on farm observation (agroecosystem analysis – AESA) and knowledge co-creation. AESA is not emphasized in CFS while AGROMETA is not emphasized in FFS. Further, blending conventional with traditional weather prediction is not emphasized in CFS but is covered in FFS [17].

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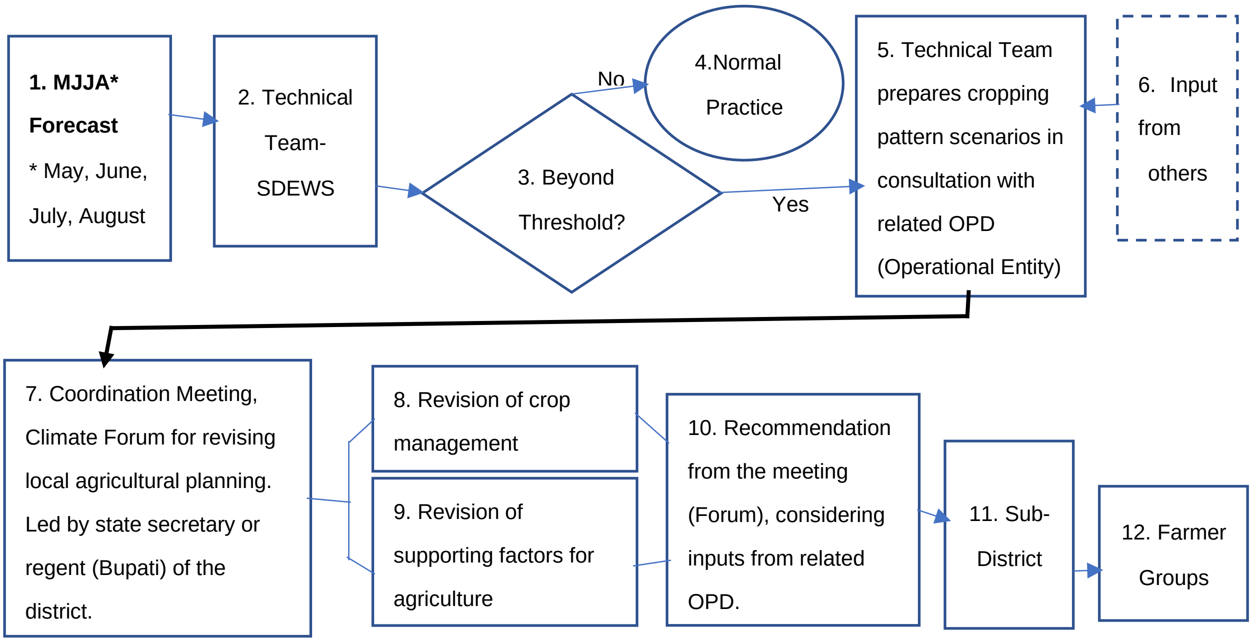

Figure 2: Steps in the flow of technologies or district instructions to farmers under CFS: Institutional arrangements for the Seasonal Disaster Early Warning System (SDEWS) in Indonesia. Source [13]

Table 1: Key features of differences between Farmer Fields Schools and Climate Field Schools

Factor	**Principal emphasis**	
	Farmer Field school (FFS)	**Climate Field School (CFS)**
Approach	Largely bottom-up [13,15]	Largely top-down [12]
Major focus	Integrated Production and Pest Management (IPPM)/ agroecosystem analysis (AESA) Experiments/ Participatory Technology Development (PTD)	Climate/ agrometeorological analysis (AGROMETA), Weather advisories Demonstrations of "good practice" instead of "experimentation" to select the most locally suitable
Focal facility	Field site (e.g., farm)	Agro-Meteorological Station
Curriculum (Modules)	An agricultural commodity or resource e.g., plant, animal, soil, etc.	A meteorological hazard e.g., heat/cold stress, drought, flood, etc.; Translating Technical terms to practical language [15]
Key strategy	Observation and knowledge co-generation	Dissemination, following the concept of technology transfer, focusing on how to use, not how to co-generate, climate. Information [2,16]

Source: Author-constructed from the various sources cited in the table

In an attempt to fill the gap, Climate Smart Agriculture (CSA) approach and Farmer Field School (FFS) methodology blended with Climate Field School (CFS) modules have been proposed as a suitable combination [18]. The blended, innovative methodology integrates FFS with climate information in one package, borrowing and embedding climate modules from the Climate Field School (CFS) into FFS to enrich the experience. To address the problem, CCAFS EA is working with the partners to make this blending happen, by integrating climate resilience into the Farmer Field School (FFS) approach for CSA in East Africa, under CRAFT. The initiative targets four categories of beneficiaries (Figure 3), namely i) farmers and farmer organizations/cooperatives, ii) Small-&-Medium-Sized Enterprises (SMEs) in agribusiness, iii) local service providers/ extension agents and iv) government officials / policy makers. Entry points include business cases (SMEs/Cooperatives), along selected crop value chains, farming systems and institutional environment. Implementation is done in Kenya, Tanzania, and Uganda.

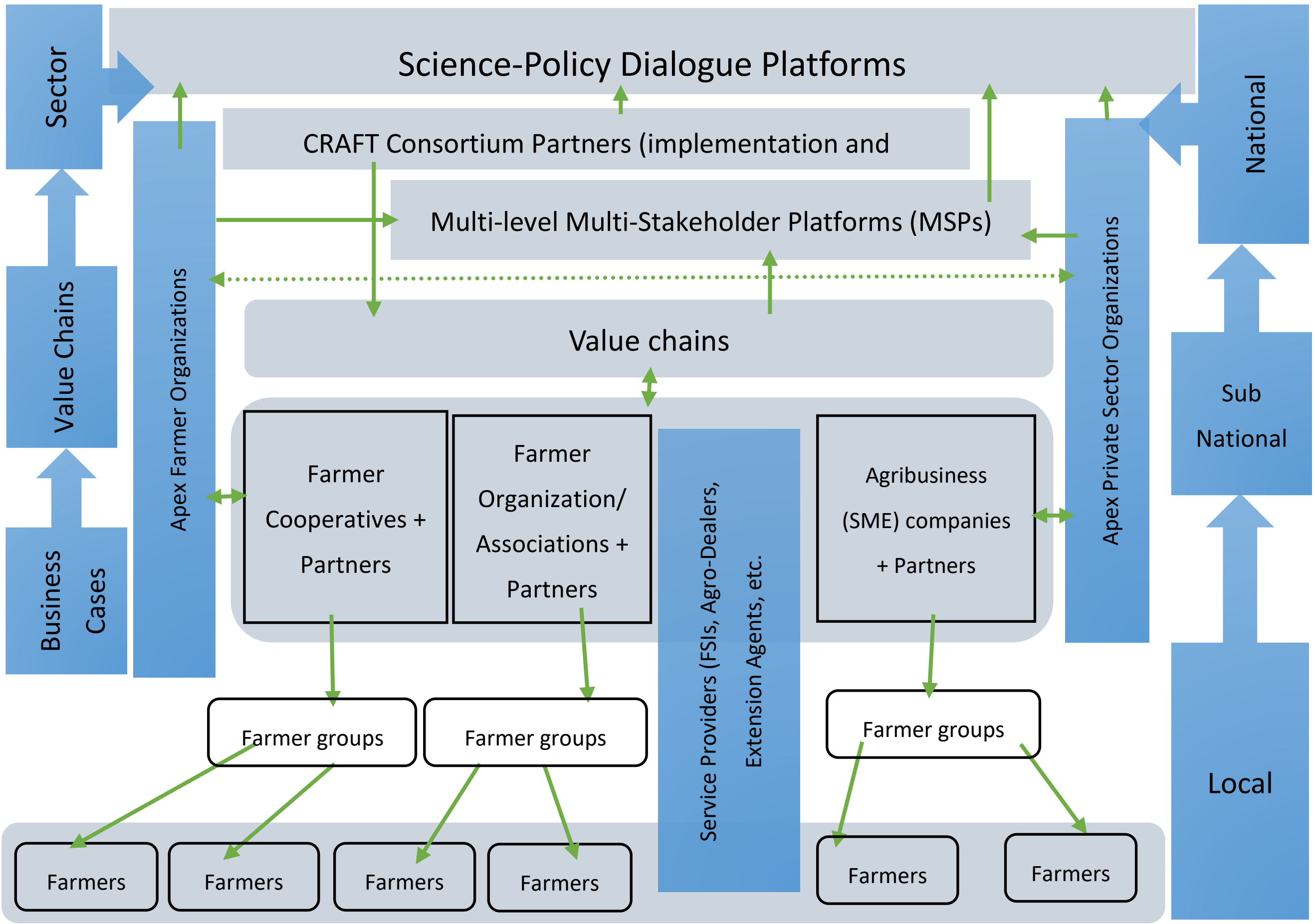

Figure 3: Schematic framework for CRAFT capacity building operations. Source: Authors

Objectives of the study

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The immediate objective of the trainings was to improve the decision-making skills of participants in the CR-FFS approach, including the use of climate information to manage climate-related risks that prevent farmers from closing yield gaps. The medium-term objective was to improve agricultural productivity, build resilience, and achieve climate change mitigation and co-benefits, where possible. The ultimate objective was to increase the capacity of actors to apply climate-smart technologies, practices, and innovations, with the aim of increasing their adoption among farmers, agribusiness SMEs, and farmer cooperatives. Specific objectives were to i) equip trainees with knowledge about climate change, climate variability and climate-related risks affecting agriculture; ii) provide participants with appropriate methodological tools to facilitate CR-FFS learning; iii) prepare participants on how to plan CR-FFS implementation; iv) prepare a climate-resilient crop production curriculum, with modules in the form of training aids for selected crops; and v) stimulate participants to share knowledge, skills and experience in local farming systems to improve production.

2. Materials and Methods

Study Area

The study area is the Climate Resilient Agribusiness For Tomorrow (CRAFT) Project mandate area, covering Kenya, Tanzania and Uganda [19]. Study area map is presented in Figure 4, showing climate trends and climate projections the initiative is responding to.

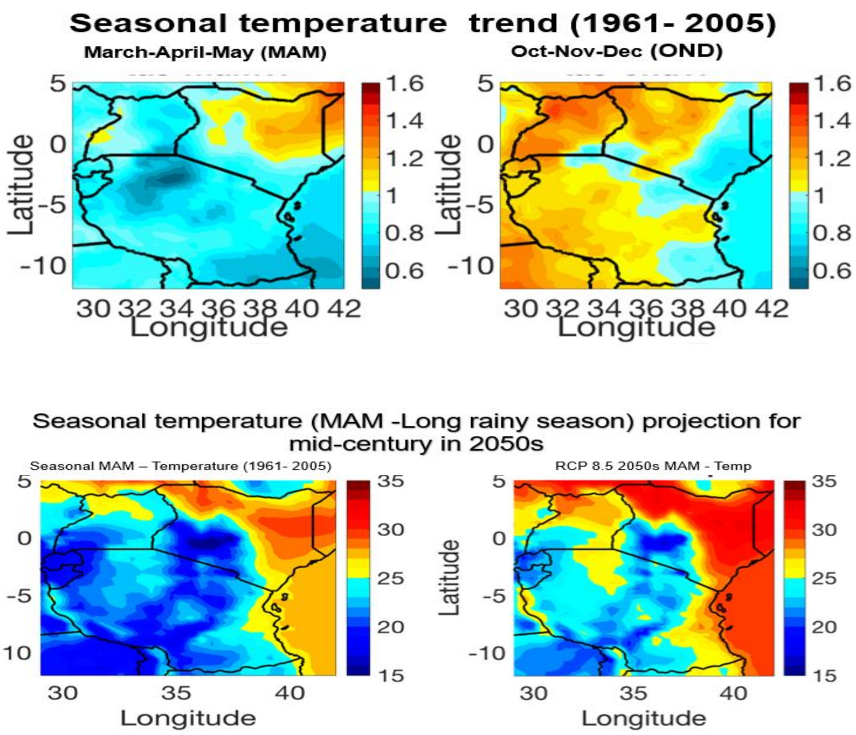

Figure 4: Study Area Map showing Mar-Apr-May (MAM) temperature trends 1961-2005 and projections into 2050s. Source: CCAFS presentation at the CRAFT Climate Risk Assessment workshop in Tanzania, April 2019.

2.1 Theory of change/ impact pathway

A theory of change or impact pathway for CR-FFS capacity building in CRAFT is provided in Figure 4. The theory of change constructed for this CR-FFS initiative was informed by, among others, hypothesized FFS results chains in [6] and [20]. Using the FFS approach, with additional climate information modules, the training and implementation focused on integrating climate-resilient agricultural practices in the value chain development of selected crops from potato, cereals, pulses and oil crops in each of the CRAFT anchor countries. The CR-FFS training of trainers (ToT/ToF) and Master Trainers (MToT) workshops were conducted between July-2019 and June-2020.

2.2 Training

The training events were led by FAO-trained FFS experts, with CCAFS providing critical input on knowledge of climate change and climate projections. Following the training of ToT/ToFs in each country, a Master Trainer (MToTs) component was conducted. Training duration was one week of 5 days for ToT/ToFs and three weeks of 15 days for M/ToTs respectively. The training materials/modules were compiled and developed into a climate resilient FFS training manual (CR-FFS). The CR-FFS approach blends both CFS and FFS approaches for maximum benefit of farmer. The basic CR-FFS learning cycle is presented in Figure 5. Participants were identified from partner business cases (agribusiness SMEs and farmer cooperatives), public and private agricultural extension agents, agro-dealers, and other local service providers. Problem identification was based on local climatic experiences. Climate information was generated by CCAFS. Focal enterprise for the training was based on value chain selected by partner business champions.

The training process comprised a bottom-up mixed methods approach of brainstorming, presentations, group work, plenary sessions, and hands-on field practical. Brainstorming helped to ground the training on local conditions and circumstances. Presentations helped to provide snapshots of complex concepts. Groupwork helped participants to get acquainted with common adult learning and Participatory Rural Appraisal (PRA) tools commonly used in FFS. Plenary sessions helped to sharpen facilitation skills and stimulate debates among participants. Field-based practical helped to bring the learning to real-world situations. The capacity building process involved employees of the partner SMEs, Agribusiness project managers, and agro dealers, Cooperatives and their farmer representatives plus sub national government agricultural officers and frontline, community-based extension agents, among others.

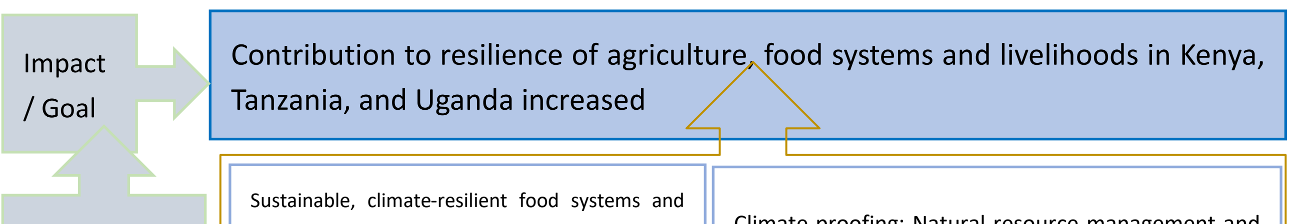

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Figure 4: Theory of Change/Impact pathway for CR-FFS capacity building in CRAFT. Source: authors

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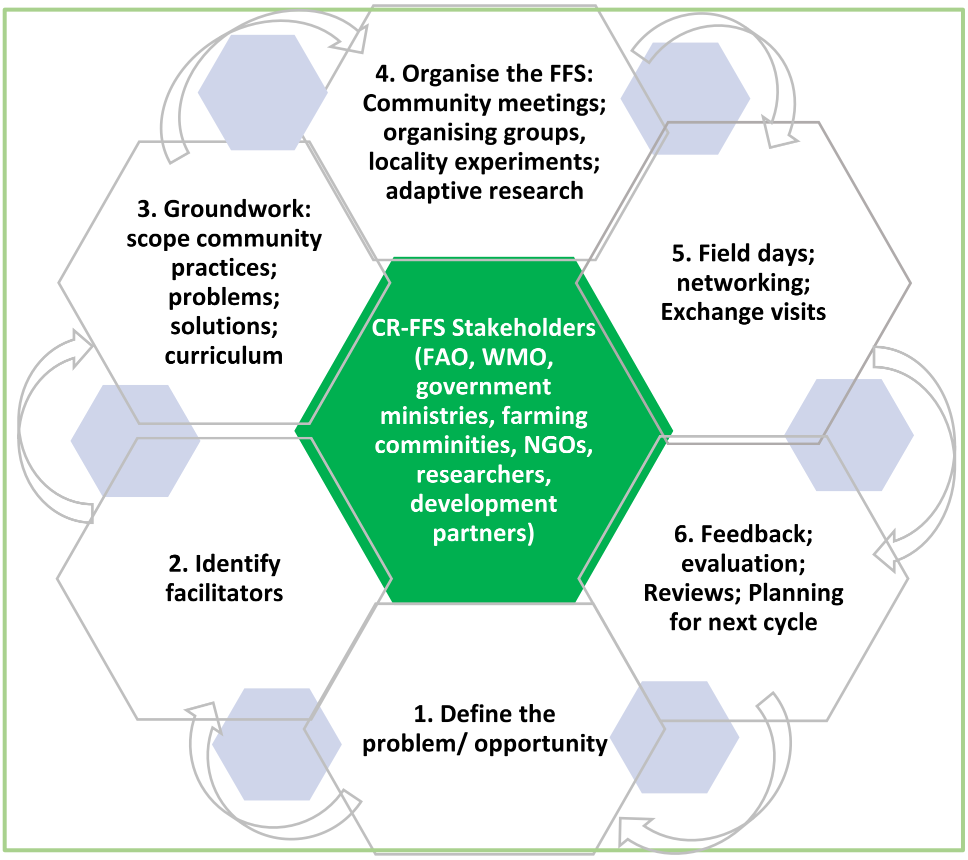


Figure 5: The CR-FFS field school basic learning cycle. Source: Adapted and blended from [10,14,15,21,22]

The number of first round trainees per country are as are presented in Table 2.

Table 2: trainees and business cases and targeted farmers per country

Country	Business Cases lined up for training in 2019	Number of participants selected by the business cases in 2019	Number of farmers targeted for training in 2020 after 2019 ToT
Kenya	11	107	23,200
Tanzania	08	215	24,500
Uganda	07	339	92500
Additional mobilization post-training	10	-	97,050
Total East Africa	**36**	**661**	**237,250**

Source: Authors

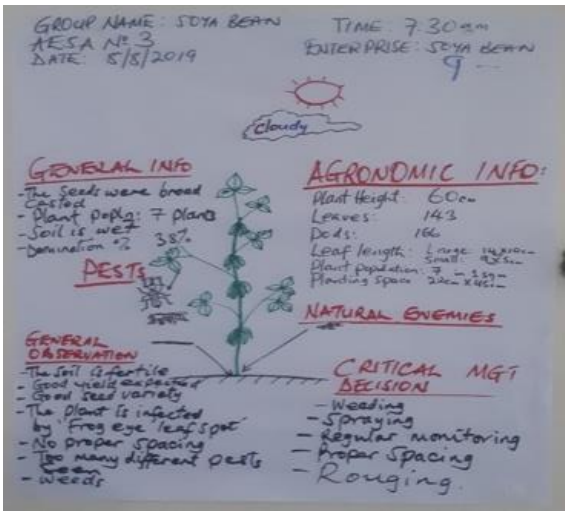
The process provides for a pre-test and post-test that participants take at the beginning and end of training, to record how much they know and how much they have learned from the process, and how they have gained from the learning. The process also includes semi-structured quiz and/or mood meters, and a "most significant change" story method of capturing change, done at regular intervals. A provision is made in the climate change modules for crop-water-weather calendar monitoring and recording, to assist in AGROMETA besides AESA. Downscaled seasonal weather forecast information is provided to the FFS by the project modelling team and the local agro meteorologist, before the FFS team begins local seasonal monitoring for comparison. AGROMETA and AESA monitoring period is decided by the group, depending on the type and nature of the focal value chain. Both indigenous weather information (using agreed indicators) and conventional/scientific weather information is observed, recorded, analysed, and reported. Data collection is done at predefined intervals using a blended AESA/AGROMETA data sheet. Both indigenous weather information (using agreed local indicators) and conventional/ scientific weather information is observed, recorded, analysed, and reported. Facilitators and participants reflect on evidence of key changes participants are observing, what shows changes are occurring, how they are occurring, what is working or not working. Discussion is conducted to blend both indigenous and conventional weather information results for better, more robust decision making and appropriate action. Storytelling is used as a way of communicating information and influencing others, but the storylines can also be used as a qualitative monitoring tool to track change.

2.3 Implementation

The implementation of CR-FFS in the three countries involved training, as ToT/ToF/ MToT, of farmer leaders, farmer cooperatives, public and private agricultural extension officers, agribusiness SMEs, agro-dealers, and other service providers; pilot implementation of CR-FFS through the selected CRAFT business cases coordinated by local facilitators who received training; and expansion of the initiative from the pilot CR-FFS groups to other CR-FFS groups in each country. To support the process, the ToT/ToF/ MToT and the project teams sensitized farmers and other value chain actors through raising awareness at institutional (policy) and local level: to advocating CR-FFS principles with national extension policies, strategies, and funding mechanisms; and developing the capacity of local partners/ institutions to support CR-FFS and to partner with other organizations to create synergies.

Data analysis

Data analysis was done using Ms Excel. The parameters analysed for training sessions includes the facilitators competencies, the relevance of the topics, the topical coverage, the method of delivery, welfare and time keeping.



ToT participants conducting an AESA session in bean-maize intercrop in Lira, Uganda – July 2019

Soybeans drawing by ToT participants for AESA in Gulu – August 2019

3. Results

Analysis of the daily evaluation indicated above average satisfaction with a score of 4.5 points on a scale of 5 points. The evaluation of the session was conducted using Likert scale to understand the level of satisfaction as strongly agreed, agreed, disagree, and strongly disagree. Results of the pre-test and post-test are presented in Figure 6. The results show that participant perception shifted greatly towards better satisfaction with what they gained during training.

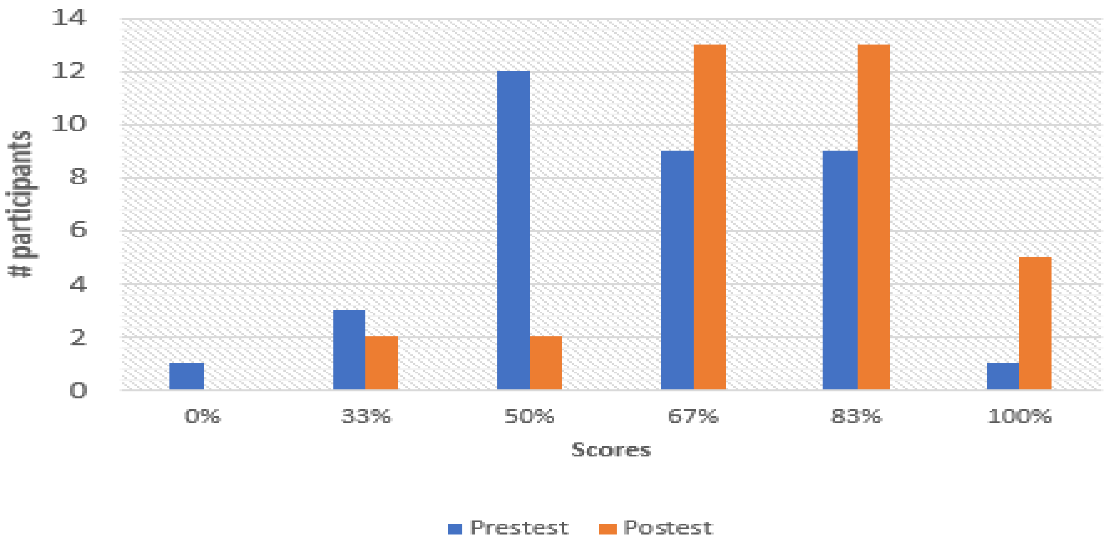


Figure 6: Learning evaluation of the pre & post test

3.1 Value chains covered

The CR-FFS training of trainers (ToT/ToF) and Master Trainers (MToT) workshops were conducted between July-2019 and June-2020 for selected value chains in each of the CRAFT anchor countries (Table 2).

Table 2: Priority value chains for CR-FFS intervention used in the CR-FFS trainings

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Country \ Crop (value chain)	Common bean	Green gram	Potato	Sesame	Sorghum	Soybean	Sunflower
Kenya	✓	✓	✓		✓		
Tanzania	✓		✓		✓		✓
Uganda			✓	✓		✓	✓

Source: authors

3.2 Trainers and Master Trainers Trained

In the first round of trainings in the year 2019, a total of 12 ToT/ToF sessions of about 50 individuals each, were conducted for seven priority value chains, four value chains per country across the region. Some 661 local CR-FFS ToT/ToFs were trained across the three countries (Figure 2), with additional 76 Master Trainers (MToTs) trained to backstop the ToT/ToFs in subsequent steps of the process. Out of the local 661 ToT/ToFs, 32% were women and 54% were youth[1] (Figure 6). By far the largest number was trained in Uganda, followed by Tanzania and Kenya. Kenya recorded the largest number of women participants while Uganda recorded the largest number of youth participants. The lowest participant age was 20 years across the three countries while the highest was 69, 65 and 72 for Kenya, Tanzania, and Uganda, respectively. The average age was 38, 37 and 34 for Kenya, Tanzania, and Uganda, respectively.

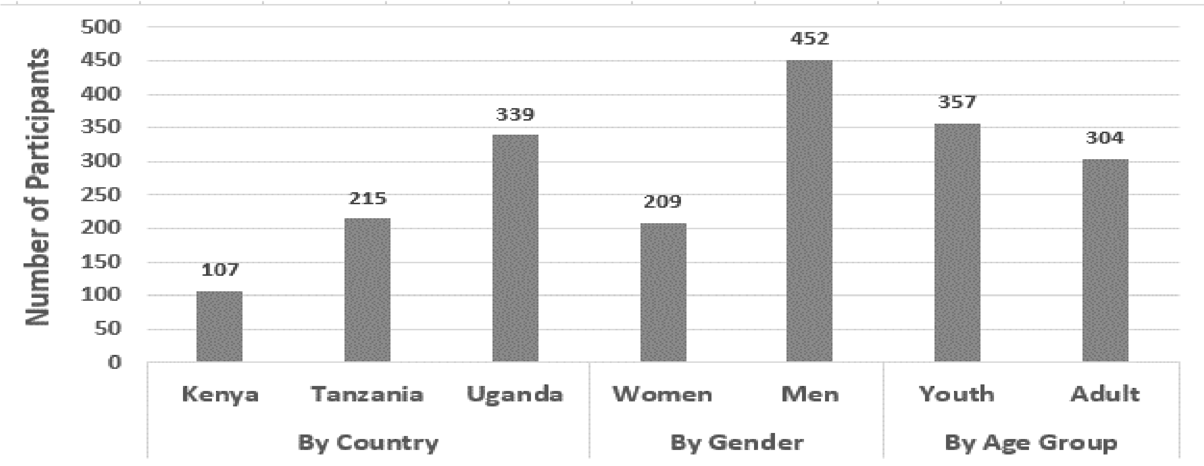

Figure 6: Facilitators (ToT/ToFs) trained by country and gender. Source: authors

3.3 Business cases and farmers reached

Through the CR-FFS ToT/ToFs and MToTs implementation, by the end of 2020, the process had reached 29 business cases (Table 3) covering a total of 1,004 farmers in Kenya, 16,247 farmers in Tanzania, and 27,665 farmers in Uganda trained on CSA technologies, practices and innovations – total 44,916 (Figure 7). Additional mobilization of 97,050 farmers in 10 business cases post-training took the tally to 237,250 by end of 2020.

[1] Note: The definition of youth applied here, of ≤35 years, is based on the African Youth Charter 2006 (African Union Commission, 2006)

Table 3: Business cases reached by CR-FFS in Kenya, Tanzania and Uganda by December 2020

Country	**Selected crops by business cases by country**							**Total**
	Potato	Cereals	Pulses			Oil Crops		
		Sorghum	Green grams	Common Bean	Soybean	Sesame	Sunflower	
Kenya	2	3	2	1	0	0	0	8
Tanzania	2	2	0	2	0	0	8	14
Uganda	1	0	0	0	9	2	2	14
Total	5	0	2	3	9	0	8	36

*One business case was an Agro-dealer SME targeting Sorghum and Green gram, so its case was split between the two crops.

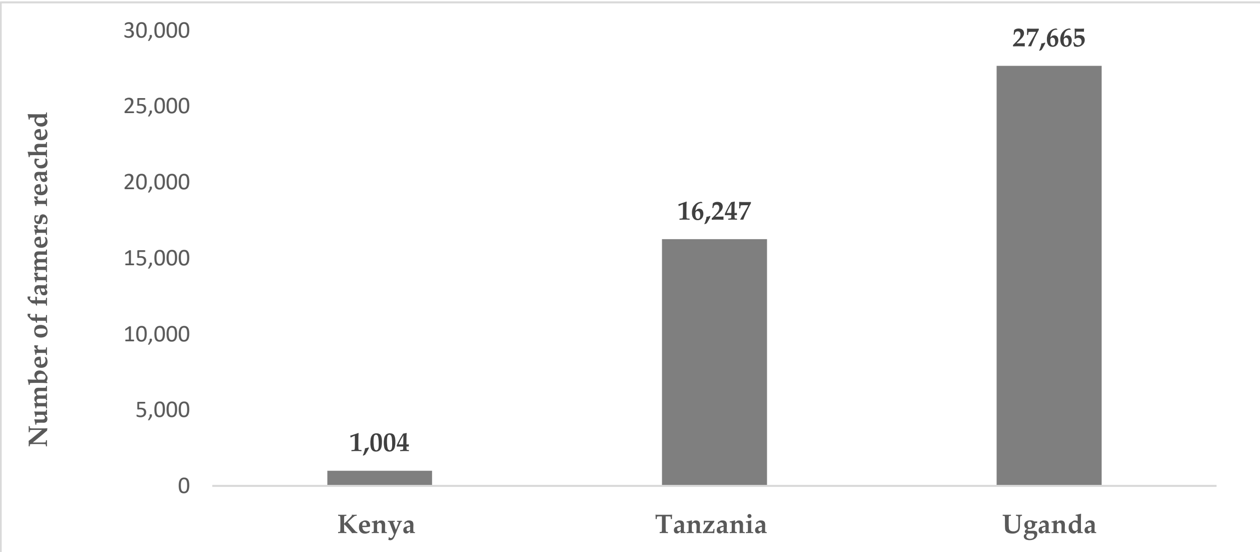

Figure 7: Number of farmers reached with CR-FFS interventions by country by December 2020.

Source: Authors

3.4 Key lessons

Analysis of the pre-and-post-training assessment indicated that the training enriched participants' knowledge of a blended CR-FFS with climate information and climate-smart technologies, practices, and innovations. It was also noted that there is a strong need to bring both agronomists and agro-meteorologists to jointly collaborate from start, instead of one of them being the main agent and merely inviting the other, as happens in the traditional FFS and CFS. The following elements of the course were mentioned as the most useful idea captured during the training: Climate-Smart Agriculture, climate change and weather forecast information, knowledge of FFS, agronomic practices including integrated pest and disease control, monitoring and evaluation of CR-FFS, presentation methods, agro-ecosystem analysis, organizing farming calendar.

4. Discussion

4.1 The methodology

The principal purpose of promoting participatory methodologies such as CR-FFS for CSA is to institutionalize adult learning, community participation, transdisciplinary research, stakeholder buy-in and ownership of the processes. The idea is based on the 'abstract-to-concrete continuum' which asserts that learning becomes more meaningful when abstract learning and concrete experience are related and combined [23] and that, in the end, learners retain and recall only 20% of what they hear but retain and recall 30% of what they see, 50% of what they hear and see, 70% of what they say and discuss, 80% of what they do and experience, and 90-95% of what they do and explain to others [23–26]. The approach builds farmers' capacity to analyse their production systems, identify local problems, test possible solutions, and eventually encourage them to adopt and adapt practices most suitable to their local farming systems. It focuses on group learning by observation, discovery, and experimentation and validation in comparison plots (as opposed to demonstration in model farms). It brings together concepts and methods from agroecology, agroclimatology and experiential learning through regular field studies, group discussion and analysis of results, exchange of experiences, and informed, collective decision making. The trainings were also used to sensitize agribusiness case champions and agricultural value chain actors on what needs to be demanded on the policy front, like the provision of downscaled climate information services from meteorological agencies. The training sensitized participants to demand the downscaling of climate information services to the localities of the participants for relevance in decision making at the local level.

4.1 The facilitator trainings and the CR-FFS processes

At 32% women and 54% youth respectively, the training selection proactively addressed gender and social inclusion by drawing more on more women and youth. Trained trainers continued with community mobilization and field activities in 2019-2020. The initial facilitators will be graduated together with their farmer participants when they complete one learning cycle together. Candidates for the role of farmer-facilitator will be identified during the first CR-FFS sessions conducted by the initial ToTs/ ToFs. The identified and selected farmer-facilitators will be taken for further training and be supported by an extensionist-facilitator to initiate and run a CR-FFS.

4.2 Priority value chains for CR-FFS intervention

The priority value chains selected for intervention, namely potato, sorghum, common bean, green gram, soybean, sesame, and sunflower, are either those that are inherently climate-resilient but do not have organised supply chains and their value chains or markets are not yet well deveoped, or those that their value chains and markets are relatively well-developed but need interventions in climate resilience, or those that fall in both categories (Table 4).

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1 Table 4: Priority value chains selected for intervention

Value Chain Cluster	Crop Value Chain	CSA Attributes	Value Chain and Market Attributes	Focus of CSA intervention requiring CR-FFS
Roots and Tubers	Potato	• Sensitive to heat stress but does better than many other major crops in shorter rainfall seasons (potato has a shorter growing period and a higher water use efficiency)	• Relatively well-developed, ready market in East Africa – especially vendors, hotels, and restaurants • Potential for production improvement in East Africa as staple and processed food, under changing climatic conditions	• Contract farming with improved varieties
Cereals	Sorghum	• More resilient to a wider range of climatic conditions than most crops in the same category	• markets for high quality sorghum grain for malting and food relief food in Kenya and Tanzania	• Supply of Agro-inputs targeting Sorghum to increase yield from application of CSA technologies, practices & innovations
Pulses or Legumes	Common bean	• More Sensitive to heat stress than most other pulses but fixes nitrogen and can contribute reduction in external fertilizer application	• Is one of the main agricultural commodities traded across East Africa: supply contracts with institutions, such as boarding schools, major hotels, and restaurants	• Common bean input and output trading with farmers, domestic and regional markets
	Green gram	• Fixes nitrogen and can contribute reduction in external fertilizer application; is more climate resilient than most other pulses	• Demand from brokers / traders and supermarkets and institutional markets; learning institutions (high schools and tertiary institutions), and	• Providing access to climate-smart services and products to increase yield from application of CSA technologies, practices & innovations, e.g., certified high yielding and drought tolerant seeds and other inputs, bulking and aggregation,

			targeting to lock-in large buyers / processors	processing (e.g. threshing), financing, land preparation, capacity building and marketing of green grams
	Soybean	• It is more climate resilient than other pulses; fixes nitrogen and can contribute to reduction in application of external fertilizer	• Demand for soybean is increasing in Uganda	• Advocacy to include soybeans as a climate change adaptation strategy in national and local climate plans.
Oil Crops	Sesame	• Drought tolerance and short growing cycle	• One of the agricultural commodities traded across East Africa; export market is growing within the region	• Promotion of sesame cultivation with improved varieties and improved agricultural practices. • Advocacy to include sesame as a climate change adaptation strategy in national and local climate plans.
	Sunflower	• Sensitive to temperature but fairly drought resistant	• One of the agricultural commodities traded across East Africa, and its export market is growing within the region	• Adopt inclusive climate smart business technologies, practices, and innovations

2 Source: authors

The main reasons for selecting the food crops were that the climate change projections and expected climate risks for the region are such that the food insecurity of many people in society will further aggravate; the cropping systems will be seriously affected by climate change; market developments for these crops show increasing consumption and sector growth; significant involvement of women and youth in production and supply of these food crops; growing private sector interests and a substantial investment potential; and possibilities to intercrop cereals with pulses and to rotate with other important crops. The uptake of agricultural technologies under conventional technology transfer model has not been very impressive in Eastern Africa countries over the years [27]. Secondly, relevancy of research themes and extension 'messages' for agricultural development has been unsatisfactory to the majority of the smallholder farmers in East Africa [28]. CR-FFS comes in as an alternative approach to enhance uptake and adoption of technologies, especially under condtions of climate change [29].

4.3 Agribusiness partners and farmers reached with the CR-FFS initiative under CRAFT

The agribusiness partners or business case champions targeted by this initiative makes the intervention operate like a farmer business school by taking the value chain approach to improve farm management and entrepreneurial decisions, based on contract farming. By close of December 2020, some 237,250 farmers had been mobilises in 36 agribusiness partnerships to implement CSA technologies, practices, and innovations across Kenya, Tanzania, and Uganda by end of 2020 despite the Covid19 pandemic. One key concept of the CR-FFS approach is to agree on the indicators of agroecosystem health and monitor these indicators through the season. Improved decision-making emerges from an iterative process of analysing the indicator results from multiple viewpoints, making decisions accordingly, implementing the decisions, and observing the new outcome *[22]*. The facilitator's role and duties include serving as catalyst, encouraging analysis, setting standards, posing questions and concerns, paying attention to group dynamics, serving as mediator and encouraging participants to ask questions and come to their own conclusions. The opportunity enables farmers to learn to improve their knowledge, change their attitudes and enhance their skills toward improved farm commercialization. Learning happens in the farm, but the curriculum covers the production cycle from planning to marketing with practical exercises based on available resources. Actions proposed by agribusiness partners to achieve different CSA objectives, including synergies and trade-offs, are presented in Table 5. Agribusiness objectives are combined with resilience objectives in the intervention to increase stability and sustainability, including the triple-win considerations for productivity, adaptation, mitigation, and synergies where possible, trade-offs where necessary. For synergies, some adaptation actions may end up achieving mitigation benefits and other co-benefits. Some mitigation actions may end up achieving adaptation benefits and other co-benefits. For trade-offs, yield may be traded off for resilience in some situations, where necessary for stability of production.

Table 5: CSA aspects in CRAFT funded business cases.

Crop value chain	**Agribusiness partner (champion)**	**Actions proposed by agribusiness partners to achieve different CSA objectives**		
		Productivity	Adaptation/resilience	Mitigation
Potato **(target 9,300 SHFs)**	• EA Fruits Farm & Company Ltd • Sai Energy & Logistic Services Company Ltd • Sereni Fries Ltd • Kisoro District Potato Growers Coop. Union Ltd	• Improved, high yielding potato varieties; expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage; greater use or refrigeration.	• Cold chain/storage facilities; irrigation; index-based crop insurance; better matching potato varieties to local climates; better weather forecasting to farmers; improved pest and disease management; more efficient water storage and management.	• Reduced deforestation coupled with intensified farming; more energy efficient technologies for pre-production and post-production (solar, refrigeration, processing, transport); soil management that conserves soil carbon.
Sorghum **(target 24,000 SHFs)**	• Farmers Pride Africa Ltd • Kibaigwa Flour Supplies limited • Quinum Investments Ltd	• Improved, high yielding (15-30% yield increase) sorghum varieties; expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage.	• More drought tolerant and early maturing varieties; index-based crop insurance; better weather forecasting to farmers; improved pest and dis-ease management; more efficient water storage and management; credit access; grain storage facilities.	• Conservation agriculture, reduced deforestation coupled with intensified farming; more energy efficient technologies for pre-production and post-production; soil management that conserves soil carbon.
Green grams	• Igambang'ombe Multipurpose	• Improved, high yielding (20% yield increase) green gram varieties;	• Drought tolerant varieties; minimum tillage/ripping; index-based crop insurance;	• Conservation agriculture, reduced deforestation coupled with

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(target 10,700 SHFs)	Cooperative Society (IMCOS) • Farmers Pride	expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage.	better weather forecasting to farmers; improved pest and dis-ease management; more efficient water storage and management; credit access; grain storage facilities	intensified farming; more energy efficient technologies for pre-production and post-production; soil management that conserves soil carbon.
Common beans **(target 6,750 SHFs)**	• Rogimwa Agro Company Ltd • Smart Logistics Ltd	• Improved, high yielding (25-35% yield increase) bean varieties; expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage	• Early maturing bean varieties; minimum tillage; index-based crop insurance; better weather forecasting to farmers; improved pest and dis-ease management; more efficient water storage and management; credit access; grain storage facilities	• Conservation agriculture, reduced deforestation coupled with intensified farming; more energy efficient technologies for pre-production and post-production; soil management that conserves soil carbon.
Soybean **(target 49,500 SHFs)**	• ACILA Enterprises Ltd • Alito Joint • Masindi Seed Co. Ltd (MASCO) • Okeba Uganda Ltd • RECO Industries • Transformation for Rural Dev. Ltd • SESACO Ltd	• Improved, high yielding (15-35% yield increase) soybean varieties; expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage.	• Early maturing soybean varieties; minimum tillage; index-based crop insurance; better weather forecasting to farmers, improved pest and dis-ease management, more efficient water storage and management; credit access; grain storage facilities.	• Conservation agriculture, reduced deforestation coupled with intensified farming; more energy efficient technologies for pre-production and post-production; soil management that conserves soil carbon.

Sesame **(target 36,000 SHFs)**	• Equator Seeds Ltd • Nyekorac Community Farmers' Coop. Society Ltd	• Improved, high yielding (15-23% yield increase) Sesame varieties with high (42-47%) oil in its seeds; expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage.	• Early maturing sesame varieties; index-based crop insurance; better weather forecasting to farmers, improved pest and dis-ease management, more efficient water storage and management; credit access; grain storage facilities.	• Reduced deforestation coupled with intensified farming; more energy efficient technologies for pre-production and post-production; soil management that conserves soil carbon.
Sunflower **(target 43,500 SHFs)**	• Mwenge Sunflower • Nondo Inv Co. Ltd • Three Sisters Ltd • Jackma Enter. Ltd • Sebei SACCO • Global Trade Ltd • Kimolo Super Rice • Khebhandza Co.Ltd • Temnar Co. Ltd	• Improved, high yielding (14-26% yield increase) Sunflower varieties with high (43-50%) oil in its seeds; expansion of agricultural land; increased mechanization; soil testing and fertilizer use efficiency; market linkage.	• Early maturing sunflower varieties; index-based crop insurance; better weather forecasting to farmers, improved pest and dis-ease management, more efficient water storage and management; credit access; grain storage facilities.	• Conservation agriculture, reduced deforestation coupled with intensified farming; more energy efficient technologies for pre-production and post-production; soil management that conserves soil carbon.

Source: authors

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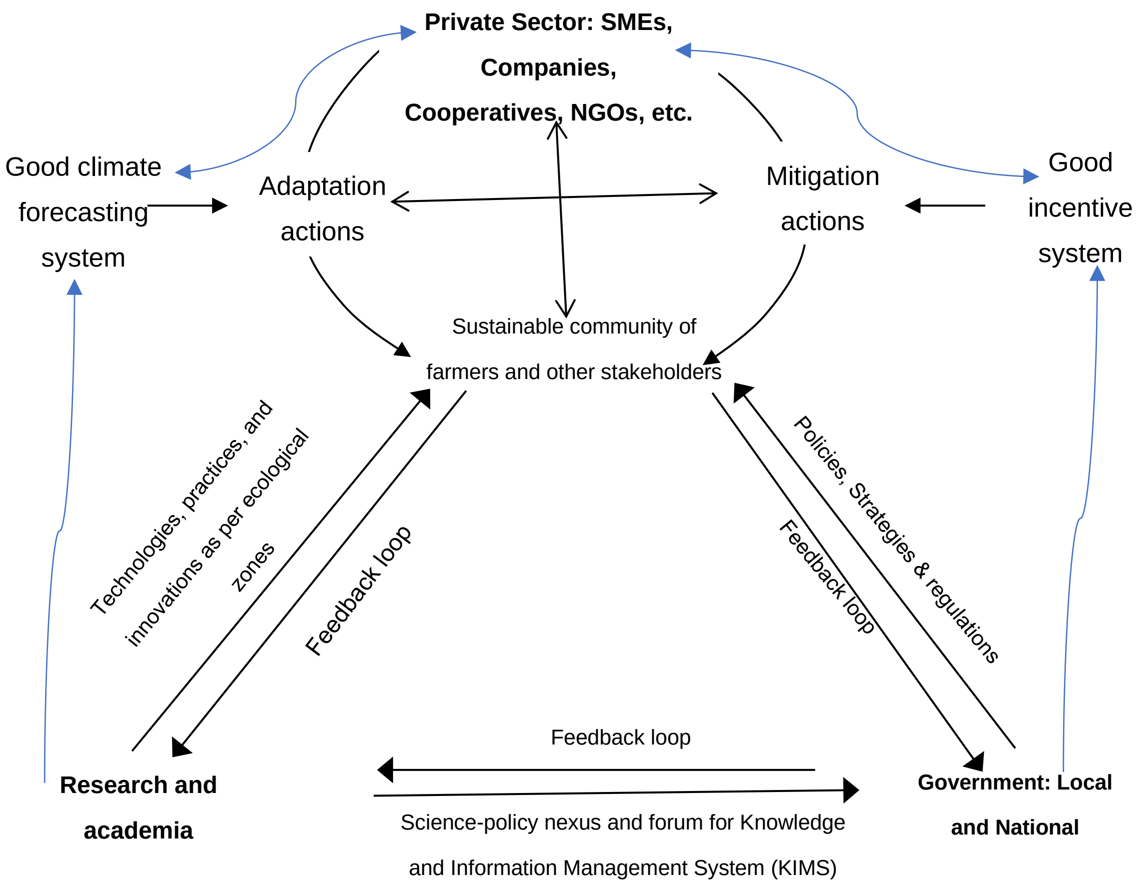
4.3 CR-FFS as an Institutional and Policy Engagement Process

Like formal, localized agricultural research initiatives, agriculture-based field school tools and methods focus on identifying concrete solutions for local problems but they apply different styles of experimentation and analysis [30]. However, both of them build local capacity for critical analysis and practical decision-making on how to manage local ecosystems, and both stimulate local innovation while emphasizing principles and processes rather than recipes or technology packages. Globally, reviews of agricultural (farmer, agropastoral, agribusiness, etc.) field school initiatives show that the approach has become a model for agricultural/ agropastoral education in many parts of the world [30]. However, to effectively incorporate climate literacy in the CR-FFS process, participants express strong opinions on the need to work more closely with available agrometeorological service providers to ensure that farmers are properly guided to participate appropriately in the "co-generation" and application of climate information and climate-informed "agro-weather" advisories for their agricultural production purposes. The field schools being formed will be coalesced into a movement of CSA CR-FFS networks to pursue this advocacy agenda from the ground [10, 31–33]. The kind of institutional framework that reflects the participants feedback is presented in Figure 8.

Figure 8: Stakeholders Engagement to institutionalize processes beyond projects and programmes.



Source(s): Adapted from **[10,32,33]**

The proposal in Figure 8 will require significant institutional commitment and support, which is currently being offered by the CRAFT project but will need institutional sustainability, driven by the private sector, when CRAFT folds up. The training and the roll-out events were found to be instrumental in empowering participants, both trainees and famers, with knowledge, skills, and attitude in the CR-FFS methodology, working like a local agricultural research forum, which will be nurtured to carry the mantle forward [22]. The anticipated institutional sustainability is being nurtured through inclusion of public extension agents in the ToTs and through policy engagement at the national level. The CR-FFS training and implementation events continue to offer lessons that can help to transform and strengthen agricultural extension and training 'from the ground up' in Eastern Africa to help farmers, farming systems, farming livelihoods and value chains become more resilient to climate variability and change, improve food security and increase rural incomes.

5. Conclusions and recommendations

This Article has presented the lessons of a climate resilient farmer field school training for climate smart agriculture implementation in East Africa. Lessons show that the trainings were instrumental in empowering participants with climate change and CIS knowledge, climate-informed agro-weather advisories, and CSA knowledge and skills. The approach blends FFS and CFS instead of treating them separately as is the case in current practice. The intervention aimed at blending the principles of FFS with those of CFS in one Methodology, for a combined CR-FFS. The intervention drew insights from the FFS and CFS approaches [4] to develop its CR-FFS methodology, combining the use of sustainable production practices with CIS. CR-FFS emphasizes both AESA and AGROMETA equally, as opposed to the current separate FFS and CFS approaches, each of which emphasizing its own AESA or AGROMETA, respectively. The intervention was used to sensitize business case champions and value chain actors on what needs to be advocated on the policy front, like participation in the local development of downscaled climate information with meteorological agencies.

However, the field school experience (in its various forms) has not been formally integrated into general, institutionalized service delivery processes, especially in East Africa, although policy documents of individual countries mention field school methodology as one of the known extension approaches. This is an area that requires further policy engagement with the governments. Kenya has noted it as an extension method in its national agricultural sector extension policy of 2012 but does not proceed to adopt it, in that document, as a method to promote in practice [34]. Document reviews for Tanzania shows that farmer field school methodology is one the extension methods used in Tanzania but there is no "one-endorsed" approach by the government of Tanzania, although the national agriculture policy of Tanzania (of 2013) states that "Junior Farmer Field and Life Schools (JFFLS) … shall be promoted" [35]. Uganda mentions it in its National Agricultural Extension Policy of 2016 and in the extension guidelines and standards of 2016 as one of the extension methods but does not expressly endorse it for promotion in the extension system [36]. The takeaway from here is that policy makers should continue to be engaged to get their opinion on formal adoption of the methodology in public agricultural system.

Questions of methodological sustainability and its use for climate services keep coming up, given that most of the FFS or CFS interventions tend to fold up when project funding dries up, due to absence of a sustainable financing model at scale to maintain the quality of the methodology. For the CR-FFS approach to be institutionalized in participatory agricultural extension in Eastern Africa, the approach needs to be incorporated into local and national agriculture policies and strategies. Policy makers will need to be engaged to get their buy-in for adoption of the methodology in formal extension systems. This may be achieved by blending and complementing CR-FFS with other modes of extension, dissemination, and communication while maintaining its original principles.

The experience from this CR-FFS capacity building activity can be leveraged to create scalable participatory extension and training models throughout the Eastern Africa region, especially through farmer-to-farmer replication methods by observation techniques and scaling up through farmer group networks. This scaling is possible if relevant authorities can develop and follow-through an enabling environment and sustainability plan for CR-FFS.

Finally, lessons from the Covid19 pandemic also calls for the need to explore the possibility of developing digital, climate-oriented farmers' field schools, that can operate despite pandemics, using mobile ICT technologies. Further, FAO has provided guidelines on how to conduct CR-FFS under of Covid19 rules [37,38]. A good example of digital FFS is documented in [39]. CR-FFS groups can use Apps to set up informal networks for information sharing. Video material is easily accessible and can be integrated in CR-FFS curricula to reach a larger population.

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