UPSCALE

UPSCALING THE BENEFITS OF PUSH-PULL TECHNOLOGY FOR SUSTAINABLE AGRICULTURAL INTENSIFICATION IN EAST AFRICA

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 861998.

D8.9

Report on Promotion events and Stakeholder Engagement

October 2023

From November 1, 2020 to October 31, 2023

UPSCALE

Author(s)/Organisation(s)	J. Pittchar (*icipe*), G. Belay, A. Detebo (ISD), J. Mugisha (FH), D. Nyagol, E. Mumbo (*icipe*), M. Otim, M. Lukaatome (NARO), I. Rwiza (TARI)
Contributor(s)	E. Poppenborg, A. Olagoke (JLU)
Work Package	8
Delivery Date (DoA)	31/10/2023
Actual Delivery Date	31/10/2023
Abstract:	Deliverable 8.9 covers activities carried out from project inception to Month 30 of the UPSCALE project in five East Africa target countries. It describes actions taken to design and deploy promotion events and engage stakeholders in the push-pull technology (PPT) innovation ecosystem to facilitate wide-scale uptake of an optimized PPT by African farmers, as well as activities aimed at mainstreaming the technology into country and regional agricultural policy frameworks. Approaches including strategic technology learning sites, farmer field days, "training of trainers" workshops, networking and training of agricultural advisers, mapping and integration of village knowledge centers and input suppliers, roadshows and media broadcasts, and workshops with local and regional stakeholder groups were undertaken. The portfolio of approaches is being leveraged to roll out large-scale awareness raising and dissemination on the benefits and practice of PPT. Methods to track dissemination impacts are implemented at project level, as well as aims to increase understanding of adoption dynamics and a breakdown of definitions for assessment of technology adoption. Through integration of PPT awareness-raising and training in mainstream practice networks and policy, UPSCALE targets widespread uptake and benefits for the practice of sustainable intensification by smallholders within and beyond the project lifetime.

Document Revision History			
Date	**Version**	**Author/Contributor/ Reviewer**	**Summary of main changes**
18/10/2023	1	J. Pittchar, G. Belay, A. Detebo, J. Mugisha, D. Nyagol, E. Mumbo, M. Otim, M. Lukaatome, I. Rwiza	Preparation of first draft
19/10/2023	1	E. Poppenborg	Review & Edits
28/10/2023	2	J. Pittchar, G. Belay, A. Olagoke	Inserts & Edits
30/10/2023	2	E. Poppenborg	Review & Edits
31/10/2023	2	J. Pittchar	Inserts & Edits
31/10/2023	2	E. Poppenborg	Final Edits

Dissemination Level		
PU	Public Deliverable	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

UPSCALE Consortium			
No	**Participant Organisation Name**	**Short Name**	**Country**
1	JUSTUS LIEBIG UNIVERSITY OF GIESSEN	JLU	DE
2	THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY LBG	ICIPE	KE
3	BAYERISCHE FORSCHUNGSALLIANZ BAVARIAN RESEARCH ALLIANCE GMBH	BayFOR	DE
4	EASTERN AFRICA FARMERS' FEDERATION SOCIETY	EAFF	KE
5	JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY	JKUAT	KE
6	KENYA AGRICULTURAL AND LIVESTOCK RESEARCH ORGANISATION	KALRO	KE
7	MASENO UNIVERSITY	MU	KE
8	FH ASSOCIATION	FH	CH
9	RWANDA AGRICULTURE AND ANIMAL RESOURCES DEVELOPMENT BOARD	RAB	RW
10	INOSENS DOO NOVI SAD	INOSENS	RS
11	UNIVERSITY OF KWAZULU-NATAL	UKN	ZA
12	LUNDS UNIVERSITET	ULUND	SE
13	SVERIGES LANTBRUKSUNIVERSITET	SLU	SE
14	UNIVERSITAT ZURICH	UZH	CH
15	TANZANIA AGRICULTURAL RESEARCH INSTITUTE	TARI	TZ
16	NATIONAL AGRICULTURAL RESEARCH ORGANISATION	NARO	UG
17	INSTITUTE FOR SUSTAINABLE DEVELOPMENT	ISD	ET
18	JULIUS-MAXIMILIANS-UNIVERSITAT WUERZBURG	UWUE	DE
19	LEIBNIZ UNIVERSITY OF HANNOVER	LUH	DE

Funding Scheme: Research and Innovation Action (RIA) ● Theme: H2020-SFS-2019-2
Project Start Date: 01 November 2020 ● Duration: 60 months

Table of Contents

List of tables

List of figures

List of Abbreviations and Acronyms	
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ATCS	Agricultural Training Centres
EC	European Commission
FTC	Farmer Training Centers
GA	General Assembly
MAC	Multi-Actor Communities of practice
JAM	Justice & Mercy NGO
NGO	Non-governmental organization
PPT	Push-Pull Technology
FDs	Field Days
WP	Work Package
FTs	Farmer Teachers
KEH	Knowledge Exchange Hub
KPIs	Key Performance Indicators
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
IPR	Intellectual Property Rights
SSA	Sub Saharan Africa
SI	Sustainable Intensification
TE	Technical Efficiency
ViKCs	Village Knowledge Centres

1. Description of the task

1.0 Executive summary

Deliverable 8.9 covers activities carried out from project inception to Month 30 of the UPSCALE project cycle in five target countries, led by *icipe* and country partners, the Institute for Sustainable Development (ISD) in Ethiopia, *icipe* in Kenya, Food for the Hungry (FH) in Rwanda, Tanzania Agricultural Institute in Tanzania (TARI), and National Agricultural Research Organization (NARO) in Uganda. It includes actions to design and deploy promotion events and engage stakeholders in the push-pull technology (PPT) innovation ecosystem to facilitate widescale uptake of an optimized PPT by African farmers, as well as mainstreaming the technology into country and regional agricultural policy frameworks.

The approach involved designing and implementing technology promotion events in the UPSCALE focal regions as nodes to expand to new potential areas as informed by the results of other linked Work Packages (WP). The partners adopted targeted farmer-to-farmer information transfer methods that enhanced gender-equity. The partners established strategic technology learning sites to visually demonstrate the technology in each target area, and in new sites identified for technology expansion. The partners organized farmer field days in the target areas each cropping season and conducted "training of trainers" workshops. They identified, trained, and worked with government and private local agricultural advisers to effectively promote the benefits of the technology and facilitate its wider uptake. Training events were organized through farmer groups linked to Village Knowledge Centres (ViKCs) which served as resource centres. They also designed and implemented a Roadshow Concept in each of the 5 focal regions as well as mass media broadcasts to create awareness on PPT. *Circa* 7.5 million people were reached with the PPT message, resulting in 11, 947 adopters, 5,109 of them female farmers.

Dissemination impacts were monitored and tracked using a dashboard with specific Key Performance Indicators (KPIs) intended to ease the reporting process, to provide a quick overview of the status for possible course adjustments, and to allow mapping of activities into the UPSCALE Knowledge Exchange Hub (KEH) for more visual presentation of UPSCALE dissemination activities. Current adoption estimates provide limited insights into the diverse and dynamic pathways they undergo to adopt PPT. Based on obtained numbers and ongoing activities, on previous studies of adoption of PPT, a quantitative assessment of the impact of different dissemination measures on the reach and levels of adoption of PPT is ongoing, as well as a study on the pathways of adoption (under WP7), and a detailed breakdown of PPT adoption dynamics through a complementary project, DYNADOPT, funded by Biovision Foundation. Partners are also identifying opportunities for devolving outreach actions towards achieving better reach and adoption, and exploring how and through which institutions they could target national policy for mainstreaming Push-pull.

Project implementation was challenged by the Covid-19 pandemic which halted all physical meetings and movement of supplies during the first year of the project. Partners countered this by adopting online meetings and mass media in place of roadshows in 2021. High input costs have also impeded the adoption of the PPT practice. The seed bottleneck is being addressed by engaging seed producers, demonstrating demand, which has resulted in improved availability of seeds, promoting community-based seed production, and influencing policy to enable certification of locally produced seeds.

Going forward, UPSCALE not only aims at technology adoption but also positive impacts on farmers' livelihoods and sustainability. Partners aim to further exploit new knowledge generated by the project

for sustainable intensification, streamline targeting and reporting, map activities for KEH and visual presentation of UPSCALE dissemination activities, obtain feedback from secondary-level disseminators, continue to streamline access to seeds and training, match farmers' needs with market opportunities, and strongly promote the uptake of UPSCALE's Knowledge Exchange Hub (KEH) and other project linkages beyond the current project cycle.

1.1 Objectives

Deliverable 8.9 – Report on UPSCALE Promotion Events and Stakeholder Engagement covers activities carried out from project inception to Month 30 of the UPSCALE project cycle in five target countries, led by the Institute for Sustainable Development (ISD) in Ethiopia, *icipe* in Kenya, Food for the Hungry (FH) in Rwanda, Tanzania Agricultural Institute in Tanzania (TARI), and National Agricultural Research Organization (NARO) in Uganda. It includes actions to design and deploy promotion events and engage stakeholders in the push-pull technology (PPT) innovation ecosystem to facilitate widescale uptake of an optimized PPT by African farmers, as well as mainstreaming the technology into country and regional agricultural policy frameworks.

The actions are part of UPSCALE project's Work Package 8 (WP8) aimed at effective exploitation, dissemination and communication of push-pull innovations in East Africa and beyond, and are related to complimentary actions to:

1. Develop and implement a communication and dissemination plan;
2. Produce documentation and communication materials oriented directly to the targeted farmers and other stakeholders;
3. Establish a multi-actor Knowledge Exchange Hub (KEH) for effective stakeholder dissemination, feedback and transfer of sustainable intensification practices to farming, research and policy communities, and the wider society;
4. Adapt the e-Granary platform to support farmers in accessing both push-pull input and output markets and forming economic groups that fit modern markets; and
5. Establish an Exploitation and IPR strategy to ensure post-project sustainability.

1.2 Strategy and Approach for UPSCALE Promotion Events and Stakeholder Engagement

The broad UPSCALE project strategy for widescale uptake of the PPT by African farmers, and for ensuring adequate policy acceptance and support involved effective communication of the technology information to the intended users. The approach involved designing and implementing technology promotion events in the UPSCALE focal regions in Ethiopia, Kenya, Rwanda, Uganda and Tanzania, and using the focal regions as nodes to expand to new potential areas as informed by the results of other linked Work Packages, as described below.

UPSCALE Promotion Events and Stakeholder Engagement built up from better understanding of key lessons learned from the stakeholder workshops, regarding agro-ecological and socioeconomic challenges and solutions gained in household survey results on socioeconomic studies for adaptation of sustainable intensification (WP1, Task 1.4); knowledge and governance impacts of upscaling push-pull (WP4, Task 4.3); lessons learned on social-ecological feedback loops of upscaling push-pull defining the key drivers and impacts of PPT upscaling and adoption at field, landscape and regional scales (WP4, Task 4.4); understanding the potential target regions where future PPT applications are likely to be most effective for targeted dissemination efforts (WP5, Task 5.1); from assessment of

options for PPT expansion and synergistic integration with other systems and practices (WP6, Task 6.1); from understanding socioeconomic and market impacts of integrating cereal PPT with high-value crops, including assessments of key production and market constraints, and facilitating sustainable access by farmers to the services they need to sustain production (WP6, Task 6.5); and understanding socioeconomic, gender, spatial, institutional, environmental and policy-related factors that impede or enable adoption of PPT (WP7, Task 7.1).

The strategy for implementation of promotion events was constantly reviewed and adjusted, informed by results being generated from other Work Packages as they evolved. Concomitant to the review and adjustment process, a documentation system was developed to track the beneficiaries reached with information. Key stakeholders were identified, and their roles defined to work through multi-actor communities of practice (MACs) with country-based partners in planning delivery of, and communicating, technology information through previously tested cost-effective dissemination pathways. The country teams defined the right strategies for disseminating technology information within their local contexts to targeted farmer groups, and implemented the most appropriate and effective training modules, schedules and processes, and linkages through their MACs.

The partners adopted targeted farmer-to-farmer information transfer methods that enhanced gender-equity, such as selection, training and engagement of female lead farmers. Technology transfer pathways included simplified print media, visual aids and advocacy events to ensure effective knowledge delivery mechanisms suitable for scaling up push-pull to different smallholder farmer typologies. The partners established strategic technology learning sites to visually demonstrate the technology in each target area, and in new sites identified for technology expansion. The country-based partners (ISD in Ethiopia, *icipe* in Kenya, FH in Rwanda, TARI in Tanzania, and NARO in Uganda) organized farmer field days in the target areas each cropping season and conducted “training of trainers” workshops in the target areas. In each locality the partners identified, trained and worked with government and private local agricultural advisers as well as influential individuals from the farmer communities to effectively promote the benefits of the technology and facilitate its wider uptake. The local trainers, being integrated within the farmer communities, worked with the project country teams to co-design the most effective strategy to reach farmers and local communities with the technological options. In this manner, target beneficiaries were profiled and matched to suitable delivery mechanisms for each demographic group.

The partners, with the support of local stakeholders, designed and implemented a Roadshow Concept in each of the 5 focal regions in Eastern Africa to create awareness on PPT and to disseminate project results in the regions. The Roadshows were public events organized with local stakeholders who helped to identify strategic locations, and opportunities within and outside the initial project focal areas, like marketplaces, schools, and other public gatherings. The Roadshows provided a public platform to introduce PPT to audience farmers and an opportunity for training them on sustainable intensification of primary production. The events served to increase public awareness and farmers’ understanding of the technology, leading to its local diffusion and uptake, as well as spreading the benefits and emerging opportunities arising from its adoption.

In the Roadshows motorised convoys of partner and local stakeholders went to the targeted locations with visually appealing supporting promotional materials (leaflets, posters, illustrations and banners), live specimens of pests and striga weed and examples of push-pull companion plants, and used loudspeakers to talk about the farmers’ production constraints, climate change effects, the need for sustainable intensification of primary production, the PPT solution, its application and benefits. The supporting promotional materials and language used was simple, culturally sensitive, and free of

scientific jargon, which enabled farmers to easily grasp the PPT framework, as well as to understand the related long term economic and environmental benefits. Where feasible and possible, the events included visiting of the push-pull fields where farmers interested in implementing the technology could directly learn from their peers. Interested new farmers were registered and linked to organized training events through farmer groups and to Village Knowledge Centres (ViKCs) which served as resource centres where local farm communities could visit and obtain information about push-pull in addition to other projects and sustainable intensification methods. The farmers were also linked to input suppliers.

A key part of the strategy and approach is a process for monitoring and evaluation of dissemination impacts, including tracking and mapping of direct dissemination activities, and tracking of downstream adoption according to dissemination type for optimizing the targeting of dissemination tools and areas. The main tool for monitoring and tracking dissemination impacts is a dashboard with specific Key Performance Indicators (KPIs) intended to ease the reporting process, to provide a quick overview of the status for possible course adjustments, and to allow mapping of activities into the KEH, for more visual presentation of UPSCALE dissemination activities in reports, and as basis for publications, including data and maps. The process is leveraging already existing data as well as emerging dissemination data to create technology reach and adoption maps. The spatial and temporal data are providing input to create visuals on the pathways of dissemination, and evolution of adoptions. The ultimate goal is to generate data that highlights action at multiple levels of society and governance, and to gain increased understanding of the reach and impact of dissemination. It is also designed to improve tracking of the impact of dissemination activities on the practice of PPT, including adaptations, integration, and further innovation for sustainable intensification.

1.3 Project Targets

In order to deliver the goals of UPSCALE Promotion Events and Stakeholder Engagement, the events described above targeted conducting at least 40 farmer teacher training events (one training event per site per season, 5 sites for 8 seasons), 160 farmer group training events on push-pull (estimated at 4 training events per site per season, 5 sites for 8 seasons), 80 farmers' field days (estimated at two field days per site per season, 5 sites for 8 seasons) and 40 review and planning workshops on technology implementation (estimated at one workshop per site per season, 5 sites for 8 seasons). The project targeted reaching information on push-pull at least 1 million stakeholders, including farmers, in East Africa by M60, among whom 25,000 were new adopters, and at least 50% of them women farmers.

2. Progress of task from project inception to M30:

The UPSCALE Promotion Events and Stakeholder Engagement actions involved:

1) Establishing strategic technology learning sites (demonstration fields) in the 5 UPSCALE target countries, Ethiopia, Kenya, Rwanda, Uganda, and Tanzania
2) Designing and implementing events for technology promotion in the focal regions (as described in the Strategy above), including the Upscale Roadshow concept, and
3) Developing and implementing training modules, schedules and processes, and linkages with MACs in the corresponding regions, and deploying targeted farmer-to-farmer information transfer methods.

2.1 Establishing strategic technology learning sites

Led by in-country partners, strategic technology learning sites were established in all target regions, and new sites identified for technology expansion. The learning sites take the form of Village Knowledge centres (ViKCs), most of which also serve as physical demonstration sites. ViKCs are community resource centres, agricultural training centres, farmer teachers, agricultural development agents. Most of the ViKCs are already existing structures. As much as possible, the partners are leveraging existing structures that already have roots in the form of institutional integration, and recognition in the respective areas, and already function as learning centers for farmers and extension. Some have physical infrastructure like community meeting halls, training and demonstration venues, or local authority offices that are used for farmer meetings or nodes for distribution of push-pull training and dissemination materials, as far as possible in local languages. They are strategically located relative to target farmer groups to promote networking and inclusion. The ViKCs ideally include demonstration plots and are not restricted to UPSCALE focus regions. The centres are also used to monitor and evaluate feedback from farmers, and to track resulting adoption outcomes.

In Ethiopia, learning sites which also served as ViKCs (see below) were established in 5 locations (see map in Figure 1) at Kebele #07 in Shewa Robit City Administrative unit, Yelen kebele in Qewot woreda, Bedeno Kebele in Dawachefa Woreda, Choriesa in Kalu Woreda, and in Tere Kebele in Qewot woreda. Three additional demonstration plots were established in the project area in Bedeno, Oromia Specialised Zone, in Shewa Robit town, North Shewa Zone, and in Delo Kebele in Welmera Woreda (not included on the map). Training was provided to least 200 stakeholders in Delo Kebele in Welmera Woreda, including 12 (1 woman) MAC management members. Farmers, local leaders and Development Agents visited the project areas at Shewa Robit Farmer Training Centres (FTCs) in Qewot woreda and Shewa Robit City Administration.

In Kenya, learning sites were established in 21 locations distributed across 5 counties: Homabay, Migori, Kisumu, Vihiga and Siaya, at *icipe* Campus in Mbita. The sites were visited by 2250 (1350 women, 900 men) farmers. Additional 4 learning sites were established by NGOs outside initial project areas – Ripple Effect in Siaya, GIZ in Busia, Justice & Mercy and Bamboo Institute in Homabay County and agricultural extension officers.

In Rwanda 20 learning sites were established in Gatsibo, Nyagatare, Muhanga, Ruhango, Ngororero, and Karongi Districts in partnership with the Rwanda Agriculture & Livestock Board and the local governments. In Gatsibo District 173 stakeholders (92 men and 81 women) visited learning sites and training centers. Overall, 905 farmers adopted as a result of trainings from technology learning sites and farmer training centers.

In Uganda learning sites were established in 28 Sites 15 sub counties and four districts. The districts are: Iganga with seven sites in Bulamagi, Nakalama, Nakigo, and Namungalwe sub counties; Kamuli with 12 sites in Bulopa, Kisozi, Nabwigulu, Namasagali, Namwendwa, and Nawanyago; Namutumba with eight sites in Kagulu, Kibale, Kiwanyi, and Magada sub counties; and Wakiso with one site established at NARO-NaCRRI. One thousand, three hundred and ninenty-six (1,396) stakeholders (763 men, 633 women) visited on-farm and off-farm training sites, either individually or in groups. 200 stakeholders (121 men, 79 women) received direct training during off-farm events while at least 1,196 people (642 men, 554 women) were trained during on-farm visits. Booklets on push-pull were given out at these events.

In Tanzania 24 learning sites were established in Tarime (5), Bunda (4), Nyamagana (1), Bariadi (1), Musoma (3), Ilemela (1), Misungwi (3), Sengerema (2), Bukombe (2), Musoma Rural (1), and Kwimba

(1). The sites were visited by at least 3500 farmers, extension staff, policy makers, region and district administrators and colleges, secondary and primary school students.

The learning sites also served as venues for field days and WP6 trials.

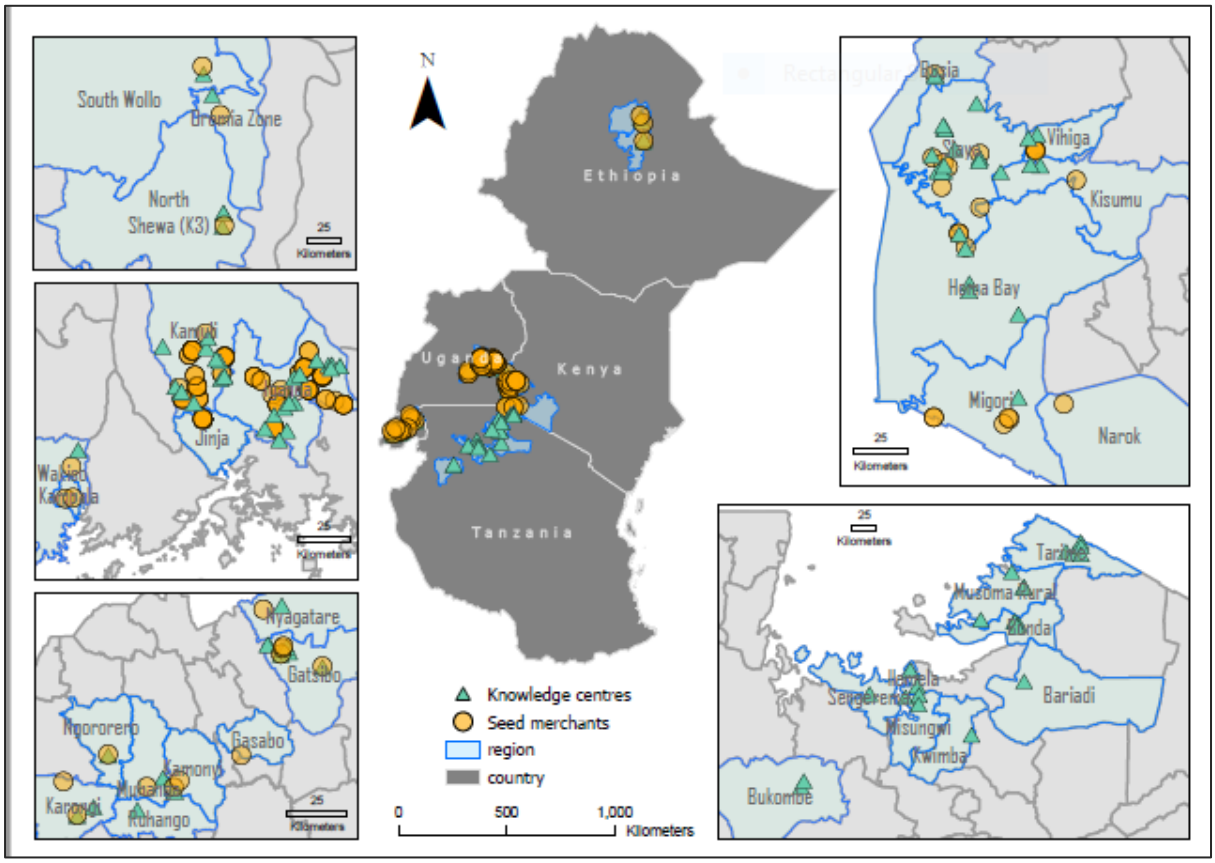

Figure 1: Spatial spread of push-pull regions, knowledge centres (ViKCs) and seed merchants in Ethiopia, Uganda and Rwanda (top to bottom on the left-hand side), and Kenya and Tanzania (top to bottom on the right-hand side). Two of the 5 ViKCs in Ethiopia (Dawachefa and Kalu Woredas) are shown with one merged symbol due to the map's resolution. Seed merchant mapping is ongoing in Tanzania.

Figure 1 represents a map of the spatial reach of technology dissemination efforts in the 5 target regions, showing the locations of ViKCs. The UPSCALE partners are matching farmers to training opportunities and farm input sources within their reach. Therefore, seed merchants are mapped as well. The pattern shows the strategic placement of ViKCs in relation to seed merchants, which is useful for catalyzing the spread of PPT knowledge and practice. Following targeted training, seed merchants and other input suppliers are expected to be able to function as additional knowledge centers and multipliers on PPT. The seed merchants are also linked to upstream seed companies for desmodium seeds. They are also provided with literature on the PPT practice to bundle with seed sales.

2.2 Designing and implementing events for technology promotion

2.2.1 Designing and planning events for technology promotion

Design and planning of events for technology promotion in the UPSCALE focal regions started with the project inception meeting (23 – 26 November 2023) in which partners established partnership and collaboration structures with local stakeholders and within multi-actor communities of practice (MACs) activities in WP1 to facilitate internal and external information exchange and relationship

building. The design of events was coordinated with the **Strategic Communication and Dissemination Plan (Deliverable 8.1)** published by INOSENS to plan for communication and dissemination of project activities and results (M3) and its update (**Deliverable 8.2**, M24). It was also coordinated with the Knowledge Exchange Hub (KEH), also led by INOSENS to facilitate awareness, wide publicity and documentation of field promotion events and dissemination. This allowed for continuous evaluation of farmers' needs, obtaining feedback, refining its dissemination and communication approach, and ensuring that the right services and content are delivered appropriately to the right recipients. This was also coordinated with the development of a mobile phone App for mobilization and registration of farmers into the e-Granary system operated by the East African Farmers Federation (EAFF).

EAFF operates a mobile-based digital platform, e–Granary, which registers farmers and links them to input and output markets and which provides farmers with on-going support throughout the growing season from seeding to marketing their crops. EAFF keeps an updated database of members, and procures directly from farmers, producer coops, and community-based organizations and manages their product value chains, while leveraging their collective strength to sell their produce. The PPT promotion and stakeholder engagement envisions using the platform as a pathway to reach a very large number of farmers through the EAFF network in Kenya, Rwanda and Uganda (See **Deliverable 8.8 - Adaptation of the e-Granary App for integration of push-pull farmers**). A sequence of 7 brief on-line tutorials on the PPT practice is being produced by INOSENS and *icipe* to be used for awareness raising and remote training and implementation including through dissemination to farmers registered on the adapted e-Granary platform. The videos and e-Granary messaging campaigns are coming on stream in the next 6 months. Following the campaigns, project country partners anticipate higher demand for training and seeds and are planning follow-up capacity both for seed provision and training requests. The mapping of ViKCs and partnering seed merchants will support matching new farmers to training venues, events and inputs supplies.

2.2.2 Implementation of promotion events and stakeholder engagements

UPSCALE partners continued to deploy different strategies for technology dissemination, training, technology diffusion processes, and linkages with MACs in the corresponding regions. Technology dissemination methods used were matched to the characteristics of the target beneficiaries. Targeted farmer-to-farmer information transfer methods, i.e., farmer teachers, field days, farmer field schools were used to disseminate Push-pull, in sync with print media, audio-visual material, and mass media (radio and television). These activities are summarized in Table 1 below. Advocacy events, including MAC stakeholder meetings (WP1) were also used to ensure effective knowledge delivery.

a. "Train the trainer" workshops:

The project adopted a cascaded model, which started with awareness creation though mass media and roadshow events, in tandem with establishment of learning sites (also served as demonstration facilities). Potential adopters were identified and organized geographically or according to local stakeholder groups. It is among these that experienced farmers, agricultural extension workers, Development agents, sector agronomists, and NGO trainers were identified and trained as trainers on the push-pull concept, its underlying scientific mechanisms (how it works), its practical application (how it is done), and its seasonal management. The "train the trainer" (ToT) workshops were conducted across all project sites in the target countries. The trained trainers, in turn, trained farmer groups and provided ongoing training as "farmer teachers".

In Ethiopia, the training of trainers extended to include training field project staff on practical sampling techniques and biophysical data collection for WP2, WP3 and WP4. Two field workers and the Crop Production and Logistics Coordinator of the UPSCALE project were trained. In Kenya, ToT workshops

were conducted in the 5 target counties, Homabay (13F, 9M), Migori (14F, 14M), Kisumu (13F, 15M), Vihiga (14F, 9M), and Siaya (10F, 8M). In Rwanda, six ToT events were conducted, in which 45 beneficiaries (23F, 22M) were trained, and 1000 brochures distributed to facilitate knowledge transfer. In Uganda, eighty (80) Tots were trained in eight trainings at eight locations (Kiyunga, Namwendwa, Bulopa, Nabikabala, Bulamuka, Butaaya, Buwooya, and Kakoola). The training was complemented with booklets on push-pull. In Tanzania, 174 (64F, 110M) ToTs were trained in 6 events on push-pull establishment and management. The beneficiaries included agricultural extension agents, lead farmers and project research staff.

b. Farmer teacher training events:

Farmers teachers are locally embedded experienced farmers, usually early adopters, who have the skills and passion to pass on knowledge to fellow farmers. They are different from ToTs, who are mainly agricultural field staff. The Farmers teachers have personal connection with their farm communities and understand the local contexts. The use of farmer teachers as extension agents was more interactive and facilitated co-learning and multidirectional information exchange. They contributed to strategies for overcoming barriers to utilization of information, understanding client information needs, and designing more appropriate information delivery approaches. Therefore, the farmer teacher training events are part of the strategy to not only deliver impactful training, but also as a measure of sustainability. The push-pull step-by-step manual and the Push-pull curriculum for farmer field schools were used as resource and reference material.

Figure 2: Farmer teacher training event in Western Kenya.

In Ethiopia, the training of farmer teachers was nested within farmer group trainings. In Kenya, 202 (114 Female) farmers teachers were trained in 15 events in Kisumu, Vihiga, Migori, Homabay and Siaya. In Rwanda, 65 farmer teachers/Lead farmers were trained in 4 seasonal events. 100 brochures were distributed. In Uganda, 219 (136M, 82F) farmer teachers were trained on push-pull in 3 training events. In Tanzania, 1,446 (524 females, 922 Males) were trained in 6 seasonal events.

c. Farmer group training events:

Group training events harnessed the natural formations of farmers with common interests. The groups tended to be cohesive, and learners mutually reinforced each other's knowledge in co-

learning. The group training courses were also cost-effective because of co-location and scale economies. Trainers used the push-pull curriculum for farmer field schools and the step-by-step manual on planting and managing push-pull as resource materials. The training events were conducted either at the learning (demonstration) sites, farmer training centres or on farms where the groups were located.

In Ethiopia, 455 (105F) farmers plus 50 (19F) Development Assistants (DAs) and agricultural extension staff were trained at Farmer training centres in Kemisse, Shewa Robit and Komebolcha. In Kenya, 198 farmer groups were trained in 12 group events in Siaya, Vihiga, Kisumu, Homabay and Migori. In Rwanda, farmer groups trainings were held in Gatsibo, Muhanga, Ruhango, Karongi, Ngororero districts. 1200 farmers organized in 35 groups were trained in 24 sessions. In Uganda, twenty-two group training events were conducted for three seasons (2022A, 2022B, and 2023A). Six hundred and one (308M, 293F) group members participated and trained on benefits, setting up and management of push-pull farms. In Tanzania, 387 (142 Female, 245 Male) were trained in 6 group training events.

d. Farmer field days:

Field days (FDs) proved to be effective tools for disseminating PPT to diversified farming communities, policy makers at different levels, service providers (e.g., extension, research, private sector) and other stakeholders. The events provided opportunities for publicizing push-pull information and sharing knowledge from on-farm field testing and research observations and for obtaining feedback from stakeholders for improving the application of push-pull. Field days were organized by participating farmer groups in collaboration with local authorities, agricultural extension agents, UPSCALE project staff, and non-governmental organizations (NGOs) supporting agricultural innovations. Typically, farmers, MAC members and other stakeholders gathered at a particular farmer's plot when the crop was almost ready for harvesting. The full effect PPT against production constraints was demonstrated, and benefits discussed with extension agents and researchers. FDs provided a forum for exchanging experiences and sharing information on best farm practices. The events fostered farmer-to-farmer technology dissemination, and direct visual assessment of the PPT benefits. Many farmers went on to test and subsequently adopted PPT on their own farms.

In Kenya, 10 field days were conducted in Kisumu, Siaya, Vihiga, Homabay, and Migori counties attended by 852 (359 male, 493 female) farmers and stakeholders. In Rwanda, 16 farmer field days were conducted in Gatsibo, attended by 960 farmers. In Uganda, four field days were conducted in Kisozi, Namwendwa, Bulopa, and Kiwanyi, attended by 279 (165 male, 114 female) farmers. Two short videos, broadcast on national Television, and one newspaper article were produced. Key attendees were farmers, local authority, district extension agents, agriculture, and production officers. In Tanzania, five field days were conducted in Mara Region, attended by 1706 (740 female, 966 male) farmers.

Figure 3: Farmers field day, Homabay County, Kenya

e. Road show events:

The UPSCALE Roadshow concept was designed to create awareness on push-pull as well as disseminate project results in each of the 5 case study regions. In the Roadshows, motorized convoys of partner and local stakeholders went to the targeted locations with visually appealing supporting promotional materials (leaflets, posters, illustrations and banners), live specimens of pests and striga weeds and examples of push-pull companion plants, and used loudspeakers to talk about the farmers' production constraints, climate change effects, the need for sustainable intensification of primary production, the PPT solution, its application and benefits. The supporting promotional materials and language used was simple, culturally sensitive, and free of scientific jargon, which enabled farmers to easily grasp the PPT framework, as well as to understand the related long term economic and environmental benefits. Where feasible and possible, the events included visiting of the push-pull fields where farmers interested in implementing the technology could directly learn from their peers. Interested new farmers were registered and linked to organized training events through farmer groups and to Village Knowledge Centres which served as resource centres where local farm communities could visit and obtain information about push-pull in addition to other projects and sustainable intensification methods. The farmers were also linked to input suppliers.

Five roadshow events were conducted in Kenya, in Homabay county (358 participants), Migori county (131 participants), Kisumu County (238 participants), Vihiga (402 participants), and Siaya (189 participants). 1,318 Upscale brochures were distributed. The roadshow generated a lot of interest, leading to two new local partnerships, with Bamboo Institute and Justice & Mercy NGO, and 210 new adoptions. In Rwanda, two road shows were conducted, attracting over 1000 farmers in Nyagihanga community. More than 600 farmers adopted this technology in Nyagihanga/Gatsibo district. At least 1000 brochures were distributed during the events. Two roadshow events were conducted in Tanzania's Bunda and Tarime districts, involving 271 participants (163 males, 108 females).

f. Review and planning workshops on technology implementation:

The design and planning of technology promotion events were continuously reviewed by WP8 partners and country coordinators in routine monthly meetings, in-country review and planning workshops in cooperation with MAC country teams.

WP8 partners held a review and planning workshop (Nairobi, 14-15 November 2022) which culminated on Agreement of Objectives for combined goals of WP8, WP1, WP7 as well as synergies with WP6 where involved partners are active in parallel. Consequently, project partners implemented:

1. Regular internal communication with reference to the workshop insights, including regular on-line and in-person meetings.
2. Reporting of Key Performance Indicators (KPIs) status (Figure 4): A matrix of KPIs was developed to ease the reporting process, allow mapping of activities for KEH, for more visual presentation of UPSCALE dissemination activities in reports, and as basis for publications (data and maps), to facilitates rapid overview of live KPI status and course adjustments by partners, including date, type and coordinates of activities, number of participants, estimated reach and impact, and upcoming events (see example of a KPI matrix in Figure 4). The matrix of KPIs also improved tracking at the ground level of the impact of dissemination activities on the practice of PPT, facilitated feedback from the next level of (indirect) dissemination through extension, government agents, community centers, training centers, MAC networks, and from participating farmers.
3. Tracking of promotion and stakeholder engagement pathways to increase understanding of the reach and impact of dissemination.
4. From March 2022 onwards, monthly meetings additionally included the discussion of synergies and information flow with WP5, culminating in an online workshop on 17 October 2023 on WP5 integration of information and data for further aims of synthesis, mapping and targeting of suitable areas for PPT expansion and dissemination, to be further built on with all partners in the context of the UPSCALE General Assembly (Uganda, Jan 2024).
5. Further, in July and August 2023 the WP8 leader undertook a mission leading in-person country workshops in all the partner countries. The workshops discussed implementation progress updates and preparations for outreach activities and promotion of adoption of the PPT practice; the targeting of national- and regional-level policy for mainstreaming Push-pull to enhance outreach and inclusion; and the devolution of Push-pull dissemination to groups outside of the partners' research domains to enhance outreach activities and adoption of the PPT practice. This included leveraging village knowledge centres, linking into the E-Granary and other potential networks in the countries, e.g., NGOs and church groups, and matching farmers to training opportunities and input supplies. The workshops also discussed the optimization of the dissemination efforts according to suitability and accessibility of the selected pathways, and tracking adoptions spatially and temporally, as well as learning and applying lessons from the country MAC activities.

Updated: 30/09/2023				Legend	Low Risk					
UPSCALE Dissemination KPI Dashboard 2020-2025					Medium Risk					
TANZANIA					High Risk					
COUNTRY KPI		Target		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulative	Progress
KEH										
K1.3	Value chain actors as push-pull supporters on the KEH	DoA set 40	Annual Target		47	5	5	5	62	
			Achieved Value		29				29	47%
UPSCALE campaigns										
K2.1	Roadshow events	DoA	Annual Target	1	1	2	2	3	9	
			Achieved Value	0	0				0	0%
K2.2	Radio and TV coverage	DoA set 200	Annual Target	1	2	5	5	5	18	
			Achieved Value	2	5				7	39%
K2.3	Farmers reached with Push-pull information through radio and TV	DoA	Annual Target	500000	500000	0	0	0	1,000,000	
			Achieved Value	14700000	22451186				37,151,186	3715%
K2.4	Non-project events where UPSCALE is presented	DoA	Annual Target	1	1	1	2	3	8	
			Achieved Value	3	2				5	63%
K2.8	Contacts for press and media	Own target setting	Annual Target	4	4	4	5	5	22	
			Achieved Value	6	6	0	0	0	12	55%
K2.9	Articles related to the UPSCALE project in online media	DoA	Annual Target	2	1	3	3	5	14	
			Achieved Value	0	0				0	0%
K2.10	Articles related to the UPSCALE project in printed media	DoA set 50	Annual Target	0	0	0	1	1	2	Downsized from 50
			Achieved Value	0	0				0	0%
UPSCALE Science & Technology Outreach										
K3.1	New adopters	DoA	Annual Target	1000	1000	1000	1000	2000	6000	
			Achieved Value	157	560				717	12%
K3.2	Technology learning sites established	DoA	Annual Target	1	4	0	0	0	5	Please populate table with data
			Achieved Value	5	6				11	220%

Figure 4: Sample illustration of a KPI matrix dashboard, using example of Tanzania

g. Mass media Radio and Television shows:

Sub Saharan Africa experiences limited capacity of extension service delivery. Extension staff are few, and not able to reach all the farmers who need technology extension services, such that not all farmers are able to get benefit from available new or improved agricultural technologies. To fill this gap, other effective and efficient information dissemination pathways are needed to reach the greatest number of farmers in the shortest time. Mass media (radio and television) is an increasingly important communication channel to promote new or improved agricultural technologies in Africa. It is the single most abundant, low-cost communication medium in rural Africa which can reach all community members irrespective of their literacy level. Radio can also be listened to alone or with a group without significant distraction to the daily activities of farmers and can significantly aid agricultural extension service delivery. Mass media (radio and television) was used in UPSCALE promotion and stakeholder engagement to create mass awareness of the PPT and to publicize upcoming promotion events.

In Kenya two radio shows were aired on Ramogi FM Luo language service, reaching 2.5 million listeners, and on Vuuka FM Luhya language service, reaching 1.2 million listeners (Source: Royal Media Services). In addition, two TV programme series known as “Shamba shape-up” were aired on Citizen TV, reaching 5.5 million viewers. Three radio shows and 1 TV show were aired in Rwanda, reaching 994,000 listeners. In Tanzania, 4 TV and 1 radio shows were aired, reaching 29,000,000 listeners. In Uganda, one radio broadcast on KBS radio reached 28,000 listeners, while two TV shows on NTV-Uganda (“Akawungeezi” prime time news) and NBStv “Afro-Mobile” programme reached 540,000 people, and over 1,800 views on the Youtube video uploaded by NTV-Uganda.

Further mass reach was achieved through partner websites and social media. ISD in Ethiopia uploaded two key publications on its website, www.isd.org.et, which have been accessed by 2,839 people:

- “Push-pull Technology: An ecological and Safeway to Control Stemborers and Striga in Ethiopia”
- “Push-pull Implementation Manual in Amharic Language”

The push-pull website, www.push-pull.net receives more than 80,000 hits monthly. In Uganda, the National Agricultural Research Organization’s (NARO) and project twitter handle reached 7,483 followers September 2023. In Tanzania Agricultural Research Institute’s twitter (X) handle reached over 14,000 followers.

h. School visits:

UPSCALE promotion and stakeholder engagement included establishing learning sites in schools and visits to schools to inform the next generation of farmers about PPT. In Kenya, one school was visited in Homabay county, taught and distributed brochures and cartoon books to 280 students (160 male, 120 female). Three schools were visited in Rwanda, reaching 981 students and 15 teachers. The Food for the Hungry field team distributed 1000 brochures and established 3 demonstration plots at the schools. In Uganda the NARO team visited two schools and reached out to 260 (140 male, 120 female) learners.

i. Production, translation, and distribution of printed material:

Complimentary to all outreach events, simplified printed materials were produced, translated into local languages, and distributed during road shows, field days, farmer training events, and school visits. The printed materials include flyers, brochures, training manuals and farmer field school curriculum.

The brochures include:

i) Upscaling the benefits of push pull technology for sustainable agricultural intensification in East Africa (UPSCALE push-pull brochure),
ii) Push pull controls the fall armyworm menace and
iii) Use the climate smart push pull technology
iv) Cartoon book for school children

Training manuals include:

(i) Push pull curriculum for farmer field schools and
(ii) A step-by-step guide for farmers and extension staff

In Ethiopia, ISD translated the UPSCALE push-pull brochure into Amharic and Oromifa regional languages, and distributed 35 copies to Agricultural officers in Oromia region.

In Kenya, 3,079 brochures, 1,580 comic books, and 220 training manuals (Push pull curriculum for farmer field school and A step-by-step guide for farmers and extension staff) were printed in English language and distributed to farmers.

In Rwanda, the push-pull brochures and Step-by-step training manual were translated in Kinyarwanda. 3000 brochures and 500 training manuals were distributed in all the project sites. In addition, 3 (1 road show and 2 press release) videos were produced and used to reach 8,000 farmers.

In Uganda, the push-pull brochures and Step-by-step training manual were translated in Luganda, and 2,500 copies distributed to farmers. In addition, a newspaper article was published on push-pull in Luganda, the most popular local language, by "Vision group" through the local daily "Bukedde" under the heading "*Enkumbi terimba*", translation: "*the hoe never lies*". The article explained the benefits and management of push-pull.

In Tanzania, TARI translated 4 brochures into Kiswahili, printed and distributed 7,269 copies to farmer groups.

j. UPSCALE Stakeholder workshops and meetings:

The project conducted Stakeholder workshops and meetings in all the focal areas with farmer associations, relevant public bodies and institutions, representatives of municipalities and the private sector. Several stakeholders' workshops were conducted in each of the partner countries. These were separate engagements from the country MAC meetings, but were conducted in coordination with their MAC teams, linking promotion and stakeholder engagement to push-pull value chain mapping, push-pull awareness and adoption strategies. For example, in Rwanda, the stakeholder workshops led to the inclusion of 2 new seed companies in the country's MAC structures to address the challenges of seed issues, helped the expansion of push-pull demos to different locations of the country to increase visibility, awareness and adoption. The national MAC meetings, although separate engagements, significantly contributed to sustainable intensification of agricultural practices, including wider application of PPT, and have helped to enhance further collaboration among the key value chain actors.

In Ethiopia, ISD hosted a national stakeholder workshop on ecological organic farming in Addis Ababa, Ethiopia on 29 December 2022. The workshop discussed perspectives from different stakeholder experiences in Promoting Organic Agriculture and Climate Resilience of Smallholder Farmers. 68 participants included participants from Government Ministries, 9 from universities/ research institutions, 9 (3F) Producers (model farmers & associations), 2 from secondary schools, 23 (4F) from

civil service society, 4 (2F) Consultants & Private sector, 5 from media & communication facilitators. In addition, ISD participated in drafting Ethiopia's Sustainable Regenerative Agriculture Road map in a workshop from 26-29th June, 2023 in Adama city, Ethiopia.

In Kenya, stakeholders' meetings were conducted on the sidelines of the Agriculture Society Kenya (ASK) show at Migori on 16th December 2022; with KALRO in Kitale; with Ripple Effect in Migori, Homabay and Bungoma, reaching 950 stakeholders; with Bamboo Resource Centre (Homabay) in June 2023; with Justice and Mercy (JAM) community integrated project (Homabay) in July 2023; and with GIZ project stakeholders in Siaya, Butere and Bungoma in July 2023.

In Rwanda FH held two stakeholders' workshops per year on PPT value chain mapping, and on PPT awareness as well as adoption strategies in Kigali. In total FH conducted 11 stakeholder meetings. The workshops resolved the agronomic challenge of implementing push-pull within a crop rotation system advocated by government policy in Rwanda.

In Tanzania, TARI promoted PPT in 13 stakeholders' meetings in collaboration with District councils in new areas outside the UPSCALE project on-implementing areas, such as Misungwi, Geita, Sengerema, Ukerewe, Busega, Magu, Ilemela, Nyamagana, Bukombe, Msalala, Musoma rural, Serengeti and Buchosa districts.

In Uganda, NARO conducted four stakeholder workshops and meetings conducted on 18th Feb 2021, 9th February 2022, and 29th June 2022, 13th December 2022. Farmers, agro-processors, district production, marketers, transporters, agricultural technology generators, and the media. The district extension officers were directly involved in the regular promotional events.

Figure 5: Rwanda Field days- MAC Members with PPT adopters in Gatsibo, Eastern Province (left). MAC members being shown the reserve area for Desmodium, which acts as source of planting materials (right).

Table 1: Number of stakeholders reached by different dissemination strategies. F: female, M: male

	Ethiopia		Kenya		Rwanda		Uganda		Tanzania		
Outreach pathway	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**TOTAL**
Demonstration sites	1	11	1,350	900	81	92	633	763	1,500	2,000	**7,331**
Training of Trainers Workshops	1	2	64	54	23	22	40	40	64	110	**420**
Farmer Teacher Training	-	-	114	88	30	35	82	136	524	922	**1,931**
Farmer group training events	105	350	92	106	460	740	293	308	142	245	**3,841**
Farmers' field days	-	-	493	359	410	550	144	165	740	966	**2,827**
Roadshow events	-	-	659	659	500	500	-	-	108	163	**2,589**
Radio and TV shows		-		5,837,000		994,000		568,000		-	**7,399,000**
Printed media and videos	-	-	2,479	2,400	1,750	1,750	1,250	1,250	3,649	3,620	**14,148**
TOTAL (mass media counted in F)	**107**	**363**	**5,842,251**	**4,566**	**997,254**	**3,689**	**570,442**	**2,662**	**6,727**	**8,026**	**7,432,087**

2.2.3 Outreach and adoption of push-pull technology

In tandem with the implementation of the above promotion and stakeholder engagement actions, the UPSCALE project tracked the spatial reach and adoption of the PPT. For the purpose of this report, we consider farmers who have implemented and are currently using the technology as adopters. Table 2 and Figure 6 below show the number of users and farmers reached through different dissemination channels. The next section provides an overview of an effort to represent adoption as a continuous, sequential, and transitioning process of 'practice change' ranging from the initial exposure to sustained utilization (and possible relapse), and subsequent post-adoption stages. This provides a more disaggregated picture of the intricacies of farmers' adoption decision process and allows for tailored outreach and support interventions for farmers at various stages of their engagement with the technology.

Table 2: Number of farmers reached with awareness and dissemination measures, and number of farmers recorded as practicing the PPT.

Country	No of farmers reached	No of users		
		Female	Male	Total
Ethiopia	476	52	137	189
Kenya	5,846,817	4,178	5,502	9,680
Rwanda	1,000,943	188	307	495
Uganda	573,104	123	80	203
Tanzania	14,753	568	812	1380
Total	7,436,093	5,109	6,838	11,947

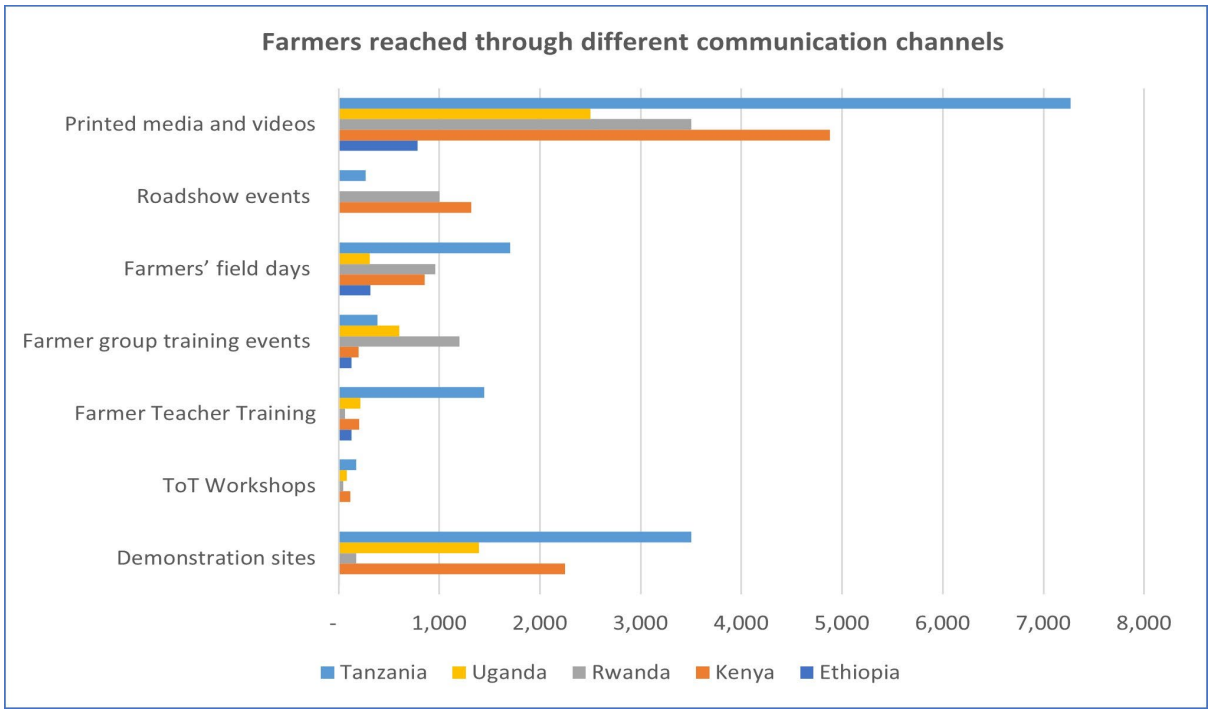

Figure 6: Farmers reached through different communication channels

Based on obtained numbers and ongoing activities, a quantitative assessment of the impact of different dissemination measures on the reach and levels of adoption of PPT is ongoing. In parallel, novel insights on the pathways of adoption (WP7) including a detailed breakdown of PPT adoption dynamics are in development (Olagoke et al., in prep; Nolte et al., in prep) and will be further investigated in the context of a follow-up project (DYNADOPT, 2024-2025; funding by Biovision). Below, we **(i)** briefly outline the qualitative assessment of implementing partners based on their experience in performing dissemination activities in all 5 countries; **(ii)** summarize key insights of existing literature on the impact of different dissemination activities. In the following **Section 2.2.4**, we outline obtained insights on the definition and measurement of PPT adoption processes on one hand, and how this relates to the impact assessment of technology dissemination on the other hand.

ISD's general observation about suitability and accessibility of technology delivery channels, identified the most suitable dissemination pathways in Ethiopia as: Local field days (Farmer-to-farmer field day training and experience sharing), direct farmer training and partner capacity building, and farmers' workshops and meetings. In Kenya, *icipe* found farmer group trainings and field days as most suitable and accessible, complemented with printed materials. In Rwanda, FH found demonstration plots, roadshows, mass media communication, and schools as the most effective dissemination channels. In Uganda, NARO found that, overall, more men participated in dissemination events than women. Field days were most suitable for the youths while demonstration site visits were most suitable for women. Youtube videos reached more of the business and working class than local farmers. Policy briefs, newspaper articles and youtube videos were more appealing to policy makers in the Ministry of Agriculture, Animal Industry and Fisheries. In Tanzania, TARI's experience was that demonstration plots were most suitable for women learners, field days for all farmer categories, while meetings and workshops suited mainly administrators, policy makers, men and women farmers, respectively. Mass media was appropriate for all categories, while social media appealed only to young farmers.

It is recognized that initial awareness of PPT and even direct engagements in trainings, demonstrations, road shows, field days and stakeholder meetings do not necessarily map linearly to eventual adoptions, but individually or in combination incrementally contribute to long term integration of the PPT in farmer's practices. While the pathways stated above are qualitative observations by partners, a formalised quantitative mapping of adoption numbers to the knowledge transfer pathways that have been applied by partners, including the resultant impacts of (a) awareness creation, (b) demonstrations and trainings, and (c) adoption is ongoing led by *icipe*.

This approach builds on previous and on-going analyses of adoption of PPT and wider sustainable technologies, which offer insights to guide dissemination efforts. These are briefly reviewed below.

Amudavi et al. (Crop Protection 28 (2009) 225–235) evaluated farmers' field days (FDs) as a dissemination tool for PPT in Western Kenya and found that participation in FDs was significantly influenced by farmer's location, formal education level, disposition to seek agricultural knowledge, and intensity of Striga infestation and low soil fertility. Knowledge and skills about PPT learnt by respondents, FD facilitators' knowledge and skills, logistical organization and overall FDs effectiveness significantly correlated with the odds of enhancing farmers' ability to plant and manage maize using PPT.

Further, Amudavi et al. assessed the technical efficiency (TE) of farmer teachers (FTs) in the uptake and dissemination of push–pull technology in Western Kenya. There were considerable benefits from training resulting in significant differences in understanding and applying of PPT. The FTs extension strategy had good technical efficiency, rated at 78%, and had a significant multiplier effect in

increasing PPT uptake. The TE was influenced by farmers' interactions with neighbouring farmers, memberships in local groups, type of farmer, farmer's age, marital status and farmer's level of education. The efficiency could be improved by providing farmers with incentives and training, increasing field demonstrations, providing Desmodium seeds and credit for other needed inputs to accelerate PPT transfer.

Murage et al. (Food Sec. (2015) 7:709-724) studied determinants of adoption of the climate-smart PPT. The study quantified the potential adoption and impact of climate-smart PPT *ex-ante* in order to plan for its wide scale dissemination. Gendered perceptions of Striga severity, technology awareness and input market access were the most likely factors that would positively influence the decision to adopt. Murage et al. (2018) further evaluated the gender appropriateness of field days in knowledge generation and adoption of PPT in eastern Africa. Econometric models showed that gender, age, education, having PPT experience, perceptions on Striga severity were the main significant determinants of farmers' knowledge of PPT, while gender of the participant, perception on stemborers and Striga weed severity and having mobile phones were the significant determinants of willingness to adopt.

Ratto et al. (Front. Sustain. Food Syst. (2022) 6:883975) conducted a mapping review of biological control interventions, including PPT, and application of botanical pesticides for insect pests of crops in sub-Saharan Africa (SSA). Studies evaluating the technical performance of biocontrol interventions dominated (73%), with a regional clustering of PPT studies in Kenya. Few studies investigated each intervention on each crop type, across different farming contexts and scales, highlighting an urgent need for landscape-scale studies to elucidate land-use impacts on biocontrol effectiveness. Limited evidence also exists on the synergistic effects of biocontrol technologies on multiple ecosystem services and on non-target/beneficial organisms. The study found an absence of interdisciplinary studies that addressed the wider indirect benefits of not using chemical pesticides, the social-economic outcomes, and barriers to adoption by farmers, which are necessary to identify pathways to greater adoption and to support policy advocacy of biocontrol interventions in SSA.

These constitute efforts to understand drivers, barriers and contexts of PPT adoption, which are being further explored in UPSCALE in the context of WP7. Existing literature has struggled to find uniform determinants and barriers to adoption. The results so far show the importance of context-dependency and adaptability to ongoing practices and motivations. To address this gap and build on the insights of WP7, a follow-up study is being undertaken under coordination of JLU, with collaborating partners *icipe* and KALRO to further examine the dynamics of diffusion and adoption of agroecological intensification practices, particularly PPT, in UPSCALE study countries. Its goal is to increase understanding of adoption pathways and how they shape the current adoption status of PPT in these regions. Ultimately, it aims to inform efficient strategies for sustained adoption of PPT and shaping future practices and policies for improved sustainable agricultural practices in the region.

Additional efforts aim to better understand ways of measuring and monitoring adoption processes for sustainable technologies and PPT in particular. Key elements of this ongoing research are synthesized below. The following section 2.2.4 summarizes the definition and classification approaches that are being developed and harmonized for PPT in Olagoke et al. (in prep), Ireri et al. (in prep) and Nolte et al. (in prep).

2.2.4 Measuring adoption as a dynamic learning and experiential process

Farmers are heterogeneous in their preferences, priorities, risk aversions, sociocultural, and other circumstances, and these contextual factors shape the nature of their decisions and engagement level

when implementing and utilizing a new practice or technology. Current adoption estimates provide limited insights into the diverse and dynamic pathways they undergo to adopt PPT. This concern arises from the growing recognition that a more nuanced understanding of the adoption process, and how to better influence farmers' behaviors and decisions, is necessary. Such understanding requires the use of an adapted staged process model of measuring and analyzing adoption as a continuum comprising different stages, grounded in emerging conceptual models and mounting empirical evidence. Farmers reached by our dissemination outreaches are being grouped along the following distinct (non-exhaustive) profiles:

1) the 'sensitization and awareness stage' regarding the production constraints, livelihood impact, and environmental sustainability problems the PPT is designed to address;

2) the 'knowledge exposure stage' where farmers access the requisite training and receive the know-how to autonomously implement and try-out the technology, being a knowledge-intensive technology;

3) the 'non-trial evaluation' stage where the farmer may contemplate, for example, based on available knowledge, or technical skill, or access to input, etc., to consider an instant implementation, or decline to accept the technology;

4) the 'intent-to-try' stage, where farmers express their interest to try on a future date when it may meet their preferences, or their resources or circumstances allow.

Next are the exploratory trials or farmers' experimentation phase, classified as 5) the 'incentivized trialing' stage depicting farmers who are provided a 'starter pack' and currently experimenting with the technology, providing feedback, and are being reached through technical backstopping to address any challenges they may encounter;

6) the 'non-incentivized trialing' category, which represents those farmers who are motivated to establish own trial plots without any subsidies, or project interventions. As with other agricultural practices with a recognizable time lag to the maturation of the full benefits, we suppose that the trial and evaluation stages may last multiple seasons (between 3-5 years) depending on the farmers' level of commitment to adequate management of the plot.

Following farmers' experimentation, own evaluation and recurrent review of the expected and the actual costs and benefits of the technology, they may consider to reach a 7) total 'discontinuance' stage, or to pause temporarily and use it intermittently with their changing preferences and prevailing circumstances, named as 8) 'opportunistic' category.

Further classifications describe continued/sustained utilizers of the technology for 5 years or more (a threshold for which a definitive adoption is understood to be ascertained), based on compliant technical configuration(s) of push-pull plots:

9) partial utilizer when all the requisite components are not implemented or maintained,

10) modified utilizer category are farmers who substitute constituent intercrops or border plants with others similar in functional traits;

The intensity of continued usage is further classified as:

11) the 'expanding utilizer' group, describing those that are committing own resources to expanding and increasing area allocated to the technology;

12) 'Relapse or decreasing continued utilizer' group, representing those who over time are reducing the land area occupied by the PPT;

13) the 'total continued utilizer' group who have undergone complete practice change and expand push-pull technology to all available land area for cereal production.

These classifications provide multiple entry points to meet the unique challenges faced by farmers at different stages of the adoption process, with tailored communication, technical support, and policy design. It also provides an opportunity to collect stage-specific feedback which can foster the adaptation, further intensification and future technology (re-)design to better meet farmers' aspirations and needs, and encourage sustainability of uptake both within and beyond the time frames of supporting projects and incentive programmes.

2.2.5 Devolution of outreach actions towards achieving adoption targets:

Arising from these experiences of disseminating push-pull in the target countries, and lessons from different sources, e.g., MACs, and lessons learned on social-ecological feedback loops of upscaling push-pull defining the key drivers and impacts of push-pull upscaling and adoption at field, landscape and regional scales (WP4); from understanding the potential target regions where future push-pull applications are likely to be most effective for targeted dissemination efforts (WP5); and from assessment of options for push-pull expansion and synergistic integration with other systems and practices (WP6) the WP8 partner are identifying opportunities for devolving outreach actions towards achieving better reach and adoption. Feedback from the next level of (indirect) dissemination, i.e., extension networks, government agents, community centers, training centers, and MAC networks is guiding the targeting of further promotion and dissemination actions. The project is exploring other linkages beyond the UPSCALE project as well as existing opportunities to promote push-pull.

In Ethiopia, ISD hosted a national workshop for ecological organic farming, and obtained perspectives from the experience of promoting organic agriculture and climate resilience of smallholder farmers in Ethiopia, government ministries, and key stakeholders from various institutions. ISD also established a working relationship with the Ethiopia-Ministry of Agriculture in the development of the draft Sustainable Regenerative Agriculture Road map. ISD is participating as a technical committee member. Among the prioritized building blocks for Sustainable and Regenerative Agriculture is Integrated Pest Management (IPM) Practices and Technologies. Push-pull is among the key technologies in the road map for its multifaceted role in agricultural intensification. The organization is also expanding reach through regional Farmer training centres. Further, FOLU Ethiopia identified push-pull among the most promising sustainability practices, named 'best bet' sustainable and regenerative agricultural practices, for the five staple crops prioritized in FPCs (four cereals—wheat, maize, malt barley, tef—and one oil crop, sesame). ISD is also collaborating with the Movement for Ecological Learning and Community Action (MELCA), a non-governmental organization based in Ethiopia, with a programmatic framework based on the promotion and application of integrated community-based development approaches. MELCA has four programmatic areas of focus: agroecology and food systems, environmental governance, eco-friendly livelihoods, and empowerment of women, youth and children that have enabled ISD strengthen networking and promote the dissemination of the 'push-pull' technology in Ethiopia.

In Kenya, *icipe* has expanded its collaboration to devolve outreach actions. *icipe* worked with Agriculture Society Kenya (ASK) shows in Migori farmers and reached 870 more farmers. It held a joint field day with KALRO in Kitale and reached 557 more farmers. *Icipe* also worked with Ripple Effect in Migori, Homabay and Bungoma, and reached 950 more farmers. It similarly worked with Bamboo

Resource Centre in Homabay (reached 230 farmers), Justice and Mercy (JAM) community integrated project in Homabay (reached 186 farmers), and GIZ in Siaya, Butere and Bungoma (reached 750 farmers). *icipe* has also established demonstration sites in regional farmer training centres.

In Rwanda, FH is pursuing a Farmer Promoter approach, where each village has a farmer promoter. FH works through the farmer promoters to scale up awareness and adoption of technology. The Farmer Promoter approach is a government-sponsored approach that is enabling rapid transfer of messages and ensuring the sustainability of the adoption, with more impact.

In Uganda, NARO – NaCRRI has set up permanent demonstration plots on its stations. The NaCRRI facility provided ongoing demonstration and training to farmers, students and other stakeholders who visit the stations.

In Tanzania, TARI is establishing linkages beyond the immediate UPSCALE partnerships, and is using meetings and workshops with different organizations, agricultural shows, media (radio and TV agricultural programs under Ministry of Agriculture, and newspapers). TARI is also leveraging a new government programme to create employment opportunities and sustainable livelihoods for youth.

2.2.6 National policy targeting for mainstreaming Push-pull:

National project partners explored how and through which institutions they could target national policy for mainstreaming Push-pull. ISD identified the Ethiopia Ministry of Agriculture, Ethiopia Agriculture Authority, and Ethiopia Ministry of Trade & Regional Integration. *icipe* identified regional count governments, the Ministry of Agriculture and regional development organizations such as ASARECA. FH in Rwanda has worked through their MAC structure to engage the Ministry of Agriculture and Animal Resources as a policy maker to mainstream push-pull. It is also working through decentralized government agencies to ensure sustainability the pus-pull once adopted. In Uganda, NARO identified the Ministry of Agriculture, Animal industry and fisheries (MAAIF) as the most effective channel for influencing policy. NARO recommended engaging the Directorate of Animal Resources for pasture to promote fodder from push-pull for increased animal production, and the Production Directorate at the district local governments. The District Production directorate serves the coordination function as the bulk of work is done at the sub counties and is being extended to the parish level through the new policy of government called Parish Development Model (PDM). In Tanzania, TARI recommended working through the Ministry of Agriculture and the Ministry of Livestock and Fisheries by introducing the technology to the Ministers, permanent secretaries, and departments responsible for agriculture improvement and dissemination.

2.2.6.1 New opportunities in national policy/institutions

UPSCALE country partners also identified new opportunities in national policy/institutions which UPSCALE could target for mainstreaming Push-pull. In Ethiopia, ISD in collaboration with the Ministry of Agriculture agreed on best practices related to 3rd generation push-pull. There is opportunity to justify and include the technology as a best practice to be adopted in the Sustainable Regenerative Agriculture Road Map of Ethiopia. In Rwanda, FH identified decentralized government agencies to ensure sustainability of the technology once adopted. In Uganda, NARO identified several new opportunities for promoting push-pull within the national policy/institutional framework:

- Agro-industrialisation strategy: This calls for increased volumes of production to provide raw materials for industries and surpluses for food security. PPT's ability to ward off the threat of fall army worms and other pests is a candidate technology.

- Climate Smart Agriculture: PPT is one of the best practices that could be adopted in the implementation of the Climate Smart Agriculture that will commence in the financial year, 2023/2024.
- Intensification of Agriculture: This is being promoted in the small-holder farmers to increase production and production.
- Diversification of production and Enterprise mix concept: PPT can allow a thriving crop and small ruminant production. In this enterprise mix concept, farmers are able to become economically secure by earning from both crop and livestock enterprises.
- Integrated pest management strategy: PPT is a good component of the IPM.
- Organic farming/production: PPT can easily be adopted for the farming type that does not call for use of agro-chemicals.
- Agricultural Extension Policy, 2016: Appropriate advisory packages to farmers are expected to be handed on to farmers. Extension staff could easily incorporate the PPT in their routine advisory service.
- Pluralistic agricultural advisory strategy: Here, the contribution of non-state actors (NSAs) is recognised and NSAs/NGOs offering advisory service could help in popularising PPT in their areas of jurisdiction.
- Smallholders farming communities: The bulk of the farming communities are of the smallholder category. Much of the support is directed at them. PPT being a package, it could reach out to the majority of the farming communities across the country.
- One Acre Fund and 4-Acre Model, Ripple Effect etc. are some of the advisory service models that aim at intensification with good results and through them, success could be achieved with PPT.
- Existence of Agricultural Extension and Skills Management Department in the Directorate of Agricultural Extension Service could make PPT one of the training modules with content for adoption across the land.
- Government support to large-scale farmers: PPT could be introduced to large-scale farmers for the several advantages that it offers as will be made known to them.
- In Tanzania, TARI also recommended using the technology's multiple entry points to target specific government programmes: soil fertility improvement, stemborer, FAW and Striga control and livestock fodder.

2.2.7 Challenges encountered, and how they were mitigated:

The Covid-19 pandemic halted all physical meeting and movement of supplies during the first year of the project. Partners relied heavily on online meetings. Another challenge was scarcity of seed for Desmodium and Bracharia and the associated poor germinability. This was solved by distributing starter seed to some members and training them on how to use vegetative propagation with cutting (for Desmodium) and splits (for Bracharia). This also solved the problem of low germinability of seed. Engagements are also ongoing to encourage local seed merchants to stock Desmodium and Bracharia seed, as well as community-based contract production.

In Ethiopia, movement was restricted on the Amhara and Oromiya Regions because of localised insecurity caused by war. ISD also faced a cultural challenge of farmer's dependency on free or subsidized inputs and free grazing of animals, instability of Expert and Woreda Agricultural official due to frequent reshuffling, and lack of technical knowledge of the technology at all the structural levels. ISD mitigation measures included working in close collaboration with their MAC structures and the Ministry of Agriculture in setting direction and strategic platforms for PPT dissemination at national

level. Secondly, establishing close ties and collaboration with the Zonal and Regional Agricultural Offices. This partnership enabled the project team to address potential problems related to input supply, ensured uninterrupted continuation of research and demonstration activities, as well as local security issues. As a standard practice this was planned in close collaboration with farmers and other stakeholders to enhance acceptability, relevance/uptake and evaluating a range of aspects including the agronomic design of the integration and planting arrangements.

In Tanzania, the main challenges were: Unfavourable weather conditions (drought/unreliable rainfall in most of the areas), lack of Desmodium seeds, free grazing of livestock that resulted in destruction of PPT fields (making PPT seasonal rather than perennial), while some of policy makers and administrators took a long time to understand the importance of PPT. TARI worked with icipe to access Desmodium seeds from Kenya, and worked more intensively with the local government structures to raise awareness of Push-pull and to manage the culture of free grazing.

Input costs (Desmodium and Brachiaria) have been a hindrance to the adoption of PPT practice. Currently, Desmodium seeds cost between €20 – €40 per kg and unaffordable for most farmers. Currently, seeds are mostly imported into the East African region from Australia which limits their availability at critical periods of crop establishment. *icipe's* strategy to address the seed bottleneck has included (1) conducting a regional workshop for small and medium-sized companies to discuss local production and distribution of Desmodium seeds, (2) demonstrating demand for Desmodium and brachiaria both for PPT and animal forage to seeds companies, which has resulted in improved availability of seeds through Kenya Seed Company, Simlaw Seeds (for Desmodium) and Advantage Crops (Brachiaria seeds), (3) promoting local production through community-based seed production by farmer groups, and (4) influencing policy to enable certification of locally produced seeds. Where community-based seed production and distribution has been enabled, seed prices have dropped to about €10 per kg. Concurrently, UPSCALE partner, Maseno University in cooperation with country partners have worked on a framework for roadblock removal for adoption of PPT from insights obtained through regional MAC stakeholder meetings and GA conferences. Seed systems for brachiaria and Desmodium have been prioritized for rapid value chains development, based on suggested interventions in each country. Partners have identified agro-dealers suppling seeds in each district. These are being mapped and linked with upstream Desmodium suppliers and farmer groups. Partners are also mapping government seed programmes that can support subsidized seeds and local seed production and multiplication. In several regions where rainfall is sufficient farmers have been trained to use vegetative propagation using vines /cuttings. Ethiopia has excellent agro-ecological conditions for Desmodium production. So does Usambara region of southern Tanzania.

3. Next Steps:

The ultimate goal of the UPSCALE Research & Innovation efforts is not only technology adoption but rather positive impacts on farmers' livelihoods and sustainability. Therefore, as the project progresses, apart from adoption data, there will also be an increasing focus on socio-economic and environmental impacts. UPSCALE country partners are working to effectively engage in matching farmers to training opportunities and input supplies as well as markets to support upscaling PPT.

The partners are also set to exploit new knowledge generated by the project for sustainable intensification (SI), including expanded spatial targeting of dissemination areas according to emerging results of WP5 and effectiveness evaluation of WP8 dissemination toolbox according to the portfolio

of options, and leveraging the options for PPT adaptation to different systems and crops which expands the scope of relevant dissemination areas.

Specific actions to streamline technology promotion and stakeholder engagement include:

- Strengthening online data entry for streamlined reporting, mapping activities for KEH and visual presentation of UPSCALE dissemination activities; obtain feedback from secondary-level disseminators (MAC networks, community centres, etc)
- Creating visuals on the pathways of dissemination; Tracking the technical efficiency, cost-effectiveness, and impact of dissemination pathways; and identifying the most impactful combination of pathways.
- Leveraging existing knowledge centres/ ATCs/Community centres/farmer teachers. Updating/mapping knowledge centres as the project evolves and additional ones are established; document density and spread, governance level and frequency of visits by farmers. Establishing more demonstration sites, translating and distributing more push-pull materials in local languages; and monitoring and evaluating feedback from knowledge centres.
- Develop plan and timelines of upcoming dissemination activities per country relevance, priorities and KPI contribution (Synchronize with country budget) andfurther streamlining of dissemination efforts according to the most effective tools and optimized spatial targeting; this is facilitated by the now loosened seeds bottleneck in all the countries.
- Streamline seed access, and training access; match farmers' needs to seed supply and training opportunities and vice-versa.
- Strongly promote the uptake of UPSCALE's Knowledge Exchange Hub (KEH) and other project linkages beyond the current project cycle; mainstream Sustainable Intensification (SI) in regional and community policy and agricultural extension in strategic policy targeting.
- Explicitly address adoption challenges identified in WP7 in trainings (incl. a new generation of trainers or retraining of trainers for these adaptations) e.g. multiple crops integration, flexible field sizes, crop rotation, intercropping, relay planting or desmodium nurseries, options for addressing free grazing issues (live fences, Desmodium nurseries, community agreements).
- Farmer recruitment, documentation, awareness raising, and leveraging EAFF network of farmers, and other value chain actors, and linking farmers to opportunities.