Varietal enrichment of durum wheat and faba bean through Crowdsourcing and participatory varietal selection (PVS) at North Shoa and Hadiya zone

Crowdsourcing crop improvement

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Field performance of Durum wheat varieties distributed to farmers in North Shoa

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The Sustainable Intensification of Mixed Farming Systems Initiative aims to provide equitable, transformative pathways for improved livelihoods of actors in mixed farming systems through sustainable intensification within target agroecologies and socio-economic settings.

Through action research and development partnerships, the Initiative will improve smallholder farmers' resilience to weather-induced shocks, provide a more stable income and significant benefits in welfare, and enhance social justice and inclusion for 13 million people by 2030.

Activities will be implemented in six focus countries globally representing diverse mixed farming systems as follows: Ghana (cereal–root crop mixed), Ethiopia (highland mixed), Malawi: (maize mixed), Bangladesh (rice mixed), Nepal (highland mixed), and Lao People's Democratic Republic (upland intensive mixed/ highland extensive mixed).

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Abbreviations and acronyms

ABC	Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT)
PVS	Participatory Varietal selection
DW	Durum wheat
FB	Faba bean
M	Male
F	Female
RCBD	Randomized complete block design
SI-MFS	Sustainable Intensification of Mixed Farming Systems Initiative
WP	Work Package

1. Crowdsourcing for varietal evaluation and selection

Replacement of farmers' varieties with genetically uniform varieties, and changes in crop patterns and land uses have largely affected the magnitude of the genetic diversity of indigenous crops. This genetic erosion resulted in a significant loss of valuable genetic diversity of the crop which is important for adaptation to changing environment and source of breeding material in the future. Therefore, a solution could come from a more scalable type of participatory research: citizen science using digital "crowdsourcing" approaches. This has already shown its potential to engage large numbers of volunteering citizen scientists who jointly generate sizable datasets that allow for geospatial analysis of climate change impact. Similarly, farmer citizen scientists could provide information about crop variety performance, which would feed into a demand-driven, scalable solution to varietal climate adaptation.

The tricot crowdsourcing approach was implemented to provide farmers with packages of seeds with a special combination of three different varieties. The tricot approach allows farmers to interact with different varieties, evaluate them based on pre-defined traits as well as their evaluation criteria, and ultimately select the one they like most. Therefore, we have initiated under sustainable Intensification of Mixed Farming System (SI-MFS) initiative to the introduction of diversity of durum wheat and faba bean genotypes to be evaluated and selected by farmers in the Abamote kebele of North Shewa and Shurmo and Dijo Damala Kebeles of the Hadiya Zone.

1.1. Crowdsourcing at Abamote Kebele, North Shoa Zone

Crowdsourcing is the outsourcing of varietal evaluation and selection to crowds of relatively large numbers of volunteer farmers[1]. Consequently, farmers multiply the seeds of the highly selected variety or varieties (winner) to boost the distribution of the seeds to peer farmers to improve access to quality seeds to wider beneficiary farmers. This approach is especially important to address remote farmers from road access that is inaccessible to the formal seed system. Furthermore, the approach enhances the adoption of productive and resilient varieties as they adequately participate in the varietal selection process and have observed the attributes of the new candidate variety (ies) introduced to their locality.

The fact that selected districts are ideal agroecology for durum wheat and faba bean, we have selected these two crops and introduced different varieties to about 200 farmers at Abamote Kebele of North Shoa zone (Table 1) and 15 durum wheat varieties at Shurmo and Dijo Damala kebeles of Hadiya zone as part of the Sustainable Intensification of Mixed Farming System initiative (SI-MFS).

[1] Mengistu, D.K., Jarvi, D.I., Fada, C.2022. Participatory Diagnostic toolkits and crop improvement approaches: Participatory methods to assess and use plant genetic diversity in the field. Page 51.

Table1. Summarised information for crop types, varieties, beneficiary farmers, and data collected for the crowdsourcing activity in Abamote Kebele in 2023.

Zone	Kebele	Crop	No. of varieties*	Beneficiary farmers				Quality control
				M	F	Youth	Total	Monitoring & evaluation**
North Shoa	Abamote	DW	15	71	23	40	94	
North Shoa	Abamote	FB	11	81	19	35	100	
Hadiya	Shurmo	DW		42	8		50	Data collection supervision
Hadiya	Dijo Damala	DW		34		16	50	

*__List of durum wheat varieties__: 1) Geregera; 2) Landrace 1; 3) Landrace 13; 4) Landrace 2; 5) Landrace 3; 6) Landrace 5; 7) Landrace 7; 8) Mangudo; 9) Meket-1; 10) Melfa; 11) Mukiye; 12) Qurqure; 13) Tesfaye; 14) Utuba and 15) Wehabit

__List of tested faba bean varieties__: 1) Ashebeka; 2) Chalew; 3) Dagim; 4) Didea; 5) Gebelcho; 6) Hachalu; 7) Numan; 8) Shewa; 9) Tumsa and 10) Wolki

** Frequent field visits were performed by the research team to each study site to verify that the trials were managed well at all levels and that required data are collected by field staff.

1.2. Crowdsourcing of durum wheat at Shurmo and Dijo Damala kebeles of the Hadiya zone

15 varieties of durum wheat were distributed and planted using a tricot plot design arrangement at *Shurmo* and *Dijo Damala* Kebeles of the Hadiya zone during the 2023 cropping season. The purpose of the trial was to expose diverse varieties of durum wheat and get them evaluated and selected by individual farmers under local management conditions. This enhances the farm's varietal portfolio, one of the approaches to sustain farm productivity as well as improve its resilience to shocks.

__Varieties distributed include__: 1) Mangudo; 2) Wehabit; 3) Meket-1; 4) Tesfaye; 5) Utuba; 6) Landrace 2; 7) Qurqure; 8) Landrace 13; 9) Landrace 3; 10) Mikuye; 11) Landrace 1; 12) Landrace 5; 13) Landrace 7; 14) Melfa and 15) Geregera.

These varieties were distributed, in a combination of three, to 100 farmers (50 in Shurmo Kebele and 50 in Dijo Damala Kebele) to be evaluated and selected by the participant farmers.

1.3. Approach: Tricot field trial.

The crowdsourcing trials were conducted in both zones through a random selection of participant farmers, and then the chosen farmers were given capacity-building training before the distribution of seeds of the diverse varieties of durum wheat and faba bean. Each farmer was given three varieties to evaluate and choose the most liked and least liked ones based on a set of traits. Each variety was planted to a plot

size of 1.2m x 2.5m = 3m^2. Recruited enumerators were assigned to assist farmers in the evaluation and selection processes. It has been confirmed that all adopted farmers have grown access varieties. Farmers' GPS data was collected, and the recruited enumerators helped farmers rank the accessed three varieties of the crops using the TRICOT approach as best and worst performers for specified traits. The data is supposed to be encoded soon.
Data collection: farmers' data such as ranking of the varieties collected by recruited field assisting enumerators at both Kebeles. The data was already collected and under analysis.

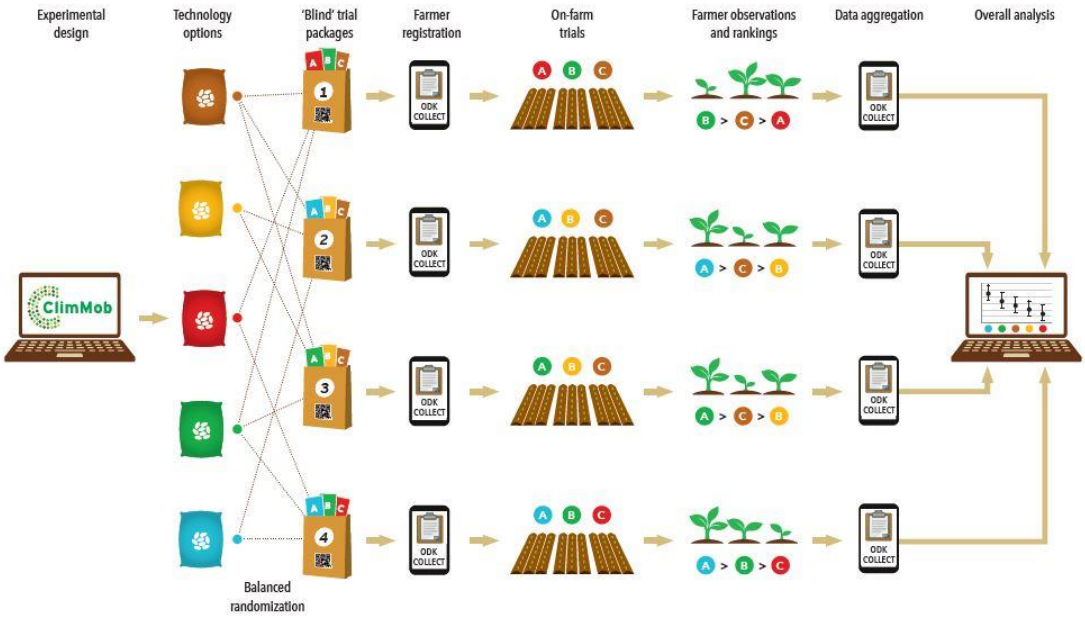

Figure 1.1 Schematic representation of the evaluation and selection process of varieties through the TRICOT approach

1.4. Expected results and outcomes

Durum wheat is a new introduction to both zones and hence information on the performance of the introduced durum wheat varieties is generated and used as a benchmark for future intervention. Varieties most liked and least liked by participant farmers are known and documented through these trials. On the other hand, the varietal portfolio of farmers for cereal crops as well as wheat increases, which in turn increases farms' resilience to shocks, ensures their food security, and diversifies farm households' nutrition for nutritional security. As this approach empowers farmers to make decisions on which variety to retain, it is expected that the chosen varieties at each zone will be cultivated in the areas for a longer time than varieties extended through the formal extension system.

Faba bean production in both zones has been threatened by various bean diseases such as chocolate spot (*Botrytis fabae*) and faba bean gall (*Olpidium viciae*). The introduction of the diversity of faba bean varieties through crowdsourcing helps to

identify varieties with resistance/tolerance to these diseases. We have observed that some of the introduced varieties are resistant to faba bean gall disease at Aba mote and Shurmo Kebeles of North Shoa and Hadiya zones, respectively. As a result, the production and productivity of faba bean in both zone is expected to increase over the coming seasons. Because pulses are an important component of a sustainable agricultural system, the identification of productive and adaptable faba bean varieties could contribute to sustainable land management of the areas, improve the nutrition of the target communities as well as increase their annual income as it is a cash crop.

2. Participatory Varietal Selection (PVS)

PVS is an approach in which breeding materials are planted together for evaluation through the collaborative participation of breeders and farmers. Varieties distributed to farmers through crowdsourcing were planted in the PVS block at both zones for joint evaluation and selection by breeders and farmers as well as to raise awareness that many varieties were introduced to the respective areas.

2.1. PVS at Abamote, north Shoa

The 15 DW varieties and 11 FB varieties distributed to farmers through crowdsourcing were planted in PVS blocks at Abamote to enable farmers to access the diversities at a single location and to make evaluations and selections of the best-performing varieties.

Durum wheat and faba bean varieties were planted using a randomized complete block design (RCBD) in two replications on 21 July 2023 and 29 June 2023, respectively and evaluated for phenological (days to heading and days to maturity), agronomic (plant height, tiller number, spike length, seeds per spike, biomass yield and Grain yield) for durum wheat and (plant height; number of pods per plant, seeds per pod and grain yield) for faba bean. Disease record for important disease on faba bean was performed using a double-digit of 00 – 99.

Data collection: data recording for important traits was completed and the data is ready for analysis. It is important to mention that the introduced faba bean varieties are also affected by faba bean gall with the severity level ranging from 40% to 100%.

The participatory evaluation of durum wheat varieties has been done by involving male and female farmers from the local area. However, participatory evaluation of faba beans was not possible because the area was not accessible due to local conflict when the varieties were at the appropriate stage for evaluation.

Participatory evaluation of durum wheat varieties at Abamote by participant farmers- a partial view

Photo: Haliu Terefe

2.2. PVS at Shurmo, Hadiya zone

All the 15 DW varieties distributed to farmers in Shurmo and Dijo Damala Kebeles of Hadiya zone through crowdsourcing were planted at the Shrumo Farmers Training Center (FTC) for demonstration, evaluation, and selection. The varieties were planted using RCBD in two replications on 28 July 2023. To discriminate the diverse varieties, both phenological (days to heading and maturity) and agronomic (number of tillers, plant height, spike length, number of seeds per spike, biomass yield, and grain yield) traits were collected. The collected data are under cleaning for analysis.

Additionally, each variety was evaluated by 10 participating farmers (5 male and 5 female) for overall performance, disease resistance, tillering capacity, yielding potential, and market value through scoring (***1= very poor; 2 =poor; 3 = average; 4= good and 5 = very good***) for each trait. Peer influence during scoring was controlled by guiding evaluators to show their fingers at a time for the score. The evaluator can show three fingers if his/her score is 3 and so on. This method was proved to be an effective way of controlling peer influence in previous studies.
The collected data is under processing for analysis, interpretation, and discrimination of the tested varieties together with the information generated from the metric data (data collected through measurement by the breeders.

Participatory evaluation and selection of DW varieties by female and male farmers at Shrumo Kebele, Hadiya zone

2.3. Expected results and outcomes.

Evaluation of the diversity of varieties through PVS enables the identification of farmers' preferred, high-yielding, and adaptable varieties that can be used to improve the production and productivity of farm households in the area. Besides, it increases the exposure of farmers to the diverse portfolio of crops and smoothens the adoption and dissemination of the selected varieties at a later stage. The PVS works conducted at North Shoa and Hadiya zones, hence, help us to identify DW and FB varieties that are high yielders, adaptable to the local growing conditions, and resistant to existing diseases. The varietal portfolio of DW and FB of each zone increases which could sustain the agricultural production of the zones. This in turn improves food and nutrition security and the resilience of farmers to climate-related shocks and stresses.

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