“Seeds for Needs” experience to improve diversity, nutrition and crop productivity



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Forward

The agricultural industry in Ethiopia is dominated by smallholder farming and rain-fed food production systems that are struggling with dwindling diversity and expanding mono-cropping. In order to address diversity, food security, and nutrition, sustainable agricultural production systems must place a greater emphasis on the efficient protection and management of biodiversity and ecosystem services. Growing multiple crops in a region is referred to as crop diversification. It can be achieved by introducing new crop species or varieties, as well as by altering the current cropping system. Typically, it might refer to incorporating extra crops into an already-existing rotation. Our seeds for needs experience will play an important role in enabling agriculture to improve crop productivity, nutrition and crop diversity productivity.

Together with Ethiopian and international partners, Bioversity International has been conducting a crowdsourcing methodology and crop improvement strategy under the name "seeds for needs" since 2010 in order to comprehend and study the potential of these varieties in underserved areas and to improve the resilience of the communities where these varieties are grown. The main objective was to provide variation so that farmers could adjust to climate change.

The Seeds for Needs Initiative, which leverages the genetic diversity already present to discover traits for adaptation to climate change, has been successfully implemented by Bioversity International. With the help of farmers, particularly women farmers, Seeds for Needs uses a participatory approach to choose a set of crops and varieties that will be further tested under their farming conditions using a crowdsourcing technique.

The registration of two varieties in the Tigray region, development of more than 6000 recombinant inbreed lines and their adoption by smallholder farmers in Tigray, Amhara, and Oromia, and a number of scientific paper publications that highlight the most important traits of these varieties—including their high grain and biomass yield in marginal environments, resistance to diseases, and adaptability to climatic conditions that change from year to year—are among the most significant outcomes of these studies.

Introduction

To fulfil the demands of a growing population, agriculture must provide food and feed that is healthy, high-quality, and safe in an efficient, sustainable manner. Because of climate change and the necessity to preserve local agricultural production, food production will encounter challenges in the future. As a result, sustained effort is required to grow crops with higher and more reliable yields in a range of changeable environments.

The services provided by biodiversity and ecosystems are essential to the sustainability and resilience of production systems, livelihoods, human well-being and environmental health. Crop diversity, including wild relatives, underpins production systems, provides food and enables adaptation to change. This would not be possible without diversity in crop production. Despite their important role, the biodiversity of producing native species is still threatened, underestimated and neglected.

Agrobiodiversity is the result of natural choice approaches and
the careful choice and inventive developments of farmers, herders and fishers over millennia. Agrobiodiversity is a crucial sub-set of biodiversity. Many human beings food and livelihood security depend on the
sustained management of various organic resources which can be crucial for food and agriculture. Agricultural biodiversity, additionally referred to as agrobiodiversity or the genetic resources for food and agriculture (FAO 1999).

The current agricultural production system is based on low diversity and high chemical inputs, which undermines the long-term sustainability of food systems and the essential ecosystem services. The transition to diversified and sustainable production systems is essential and urgent, and depends on our ability to harness the transformative power of agricultural biodiversity. Such transitions, coupled with improved conservation practices, will reduce pressure on terrestrial and marine ecosystems by protecting productivity, restoring ecosystem services and improving ecological connectivity between protected areas.

Smallholder farmers' needs cannot be addressed by one-size-fits-all approach in areas where the agroecological conditions are varied and farmers have different crop trait preferences. The conventional plant breeding strategy of using a narrow array of genetic

stock ignores the high potential offered by genetic resources available in various gene banks. Moreover, this strategy increases the vulnerability of agriculture in the current climate change setting. To improve crop productivity in regions where formal seed systems do not exist and a number of participatory techniques to variety development and transmission have been developed to target the diverse environments, crops, and varieties for Ethiopian farmers. Crowdsourcing, community seed banks, seed fairs, participatory variety selection and participatory plant breeding have all been utilized to promote innovation, access to seeds, and diversity in informal seed systems.

The Seeds for Needs (S4N) approach, which combines genomics, conventional breeding, and farmers choices through crowdsourcing, aims at testing many varieties in farmers' fields to select best performing superior varieties for specific climatic and edaphic growing conditions. By bringing seeds to farmers' fields, women and men farmers have an opportunity to select varieties that can fulfil their needs and that are more tailored to their specific farms, with traditional knowledge taking a front seat in the management process.

Main components

I. Definition and Components:

What is Crowdsourcing?

Crowdsourcing is the practice of outsourcing the work to large groups of unpaid volunteers who contribute their skills and time to group efforts is known as crowdsourcing (Schenk, Eric; Guittard, Claude, 2009). Crowdsourcing-based interventions, made possible by modern information technology, become useful to advance informal seed-based system.

One of the advantages of crowdsourcing approach is used to improve agrobiodiversity. Agrobiodiversity refers to the variety and variability of living organisms that make contributions to food and agriculture inside the broadest experience, and which are related to cultivating crops and rearing animals within ecological complexes. It is in addition expanded in a few contexts to consist of all of the organisms present in an agricultural landscape. Examples encompass crops and animal breeds, their wild relatives, and the species that interact with and support those species, as an example, pollinators, symbionts, pests, parasites, predators, decomposers, and competitors. Crop lands and

fields in addition to habitats and species outdoor of farming structures that have an effect on agriculture and surroundings features in agricultural panorama are included. Agrobiodiversity also can consult with the extraction and utilization of products from natural ecosystems which include nonforest timber merchandise, or livestock that pasture in grasslands. Utilization and conservation of biodiversity in agricultural landscapes is strongly encouraged through socioeconomic factors at local, regional, and worldwide scales. The ideas of agrobiodiversity also are legitimate for forestry and fisheries, mainly in conditions where human activities dominate the ecosystem processes (Louise E., et al., 2013).

Since agriculture is a human activity that forms and conserves biodiversity, local knowledge and culture can be seen as essential components of agrobiodiversity. Agrobiodiversity therefore refers to the diversity of all plant resources that human cultures use and manage for agriculture, food, health care, and subsistence. It also embraces the utilization of wild foods and medicinal plants by rural residents for survival, health care, and nutrition.

By turning to an oversized cluster of individuals for ideas and solutions, crowdsourcing will generate plenty of advantages over internal thinking processes. Among the benefits of crowdsourcing is:

- The ability to find unexpected solutions by involving a broader cluster of individuals in resolution a haul, an organization will gain access to hundreds or perhaps thousands of various approaches to drawback resolution.
- Greater diversity of thinking
- Reduced management burden
- Faster problem solving
- A rich source of data

Importance of crowdsourcing approach for agricultural sectors

The fact that the varieties are grown on the farmers' fields rather as a trial plot has an additional advantage because it allows a larger number of farmers to participate and collects extra data on performance at various altitudes or in various climatic conditions.

They provide their input in an easy-to-read format, rating each package for several characteristics as "best, midrange, or worst". These farmer-generated data are then merged with socioeconomic and environmental variables and ranked using particular, cutting-edge statistical techniques. It has been feasible to show how varieties are differentially suited to various growth circumstances across broad areas using the tricot technique. Additionally, it enables a lot more farmers to take part in participatory trials, which directly impacts the spread of varieties (Bessette, G., 2018).

This strategy enables farmers serve as local scientists, testing, observing, contrasting, and trying novel agricultural methods and crop rotations to find what works best for them in terms of yield as well as resiliency, nutrition, taste, and resistance to pests and diseases.

Generally, as part of their routine duties, development agents monitor the farmers throughout the process and offer advice. They can learn with farmers about how various kinds fare in various soils and micro-ecologies in this way.

The crowdsourcing approach has been very effective in disseminate seeds that match farmers needs in a very short period as after 2 years already several hundred farmers have the potential to use better adapted material, with a large snowball effect potential (Carlo F., 2014).

With a significant potential for a snowball effect, the crowdsourcing technique has been very successful in rapidly disseminating seeds that are tailored to farmers' needs. After only two years, several hundred farmers are already able to use more suitable materials.
Crowdsourcing approach demonstrates how superior
varieties can offer an immediate solution for reducing climate-
related hazards and calls for greater use of the genetic resources preserved in gene banks; suggests that in order to sustainably manage these resources, local seed systems must be st rengthened;
It demonstrates how farmers can offer extremely useful scientific data that can be applied t o other fields of research as well as development outcomes.

Crowdsourcing approach for variety selection using tricot improve seed systems through enriches variety recommendations, improves on-farm testing, engages and empowers farmers, contributes to a diversification of seed systems, supporting scaling of on-farm

agricultural research, enables women to do their own variety selection, offers business opportunities for farmers, women and young people, gets researchers to learn farmers' variety preferences.

The crowdsourcing methodology is an alternative to conventional practices because it supports farmers' on-farm selection of varieties based on seed performance in different agroecological and climatic zones of a given location (Bessette, G., 2018). This way, the farmers got an opportunity to access different varieties of different crops. This has improved the informal seed system, through exchange and purchase of the varieties among farmers.

Crowdsourcing to improve seed system

The tricot methodology supports the scalability of on-farm agricultural research, which enhances seed systems. Because seed distribution and evaluation are significantly simpler. Information-based tasks can now be scaled to new levels that were previously impractical thanks to the tricot technique. Larger sets of types can be compared by providing farmers with alternative, partially overlapping combinations of technologies.

The method can engage a large number of farm households, which can help to get beyond the limited scalability and free-rider issue in existing participatory methodologies. As a result, it is possible to scale on-farm agricultural research using a crowdsourcing approach.

The importance of crowdsourcing for nutritional improvement

Seed-based innovation must concentrate on the variety of crops that make up farmers' fields and diets if it is to provide food for the most vulnerable households.

By adapting crop varieties to various production situations and diversifying their portfolio to reduce risks, a variety of crop species and varieties aid farmers in coping with environmental limitations. There is strong proof that dietary diversification and micronutrient intake are related (Frison et al., 2011). It is reasonable to anticipate that increasing crop diversification for farmers with limited resources will significantly improve the food security of their households. Therefore, the major strategy for improving nutrition for small-scale households is to enhance diversity through crowdsourcing approach.

Suitability and adaptability to local knowledge

The services and goods that agrobiodiversity offers, such as those related to health and nutrition, local knowledge, and environmental services, are necessary for sustainable agriculture.

Main objectives

Main purposes of sustainable use of agrobiodiversity are:

- Reducing malnutrition with food system diversity
- Conserving the environment and preventing pollution
- Reducing costs and focus on profits
- Improving food production without being wasteful

Potential to increase/sustain productivity and environmental protection (impacts)

Three key goals are incorporated into the work of sustainable agriculture practitioners: a healthy environment, economic success, and social and economic equality. A sustainable agricultural system may be ensured by all participants in the food system, including farmers, food processors, distributors, retailers, consumers, and waste managers.

A deeper understanding of the functions of biodiversity in the ecological processes that support food and agricultural production is necessary for the sustainable use and conservation of the ecosystems and the species and genetic diversity that make them up.

By combining inter- and intra-specific diversity in ways that boost production, resilience, and ecosystem function, these often involve better utilizing biodiversity for food and agriculture. They frequently result in increased production of higher-quality goods as well as better ecosystem services and improved returns for farmers.

Description of the technology and steps

Sustainable management of agrobiodiversity on farms depends on:

(a) **Farmers' seed systems and participatory breeding** explains the function of farmers' informal and formal seed systems as well as their participation in plant breeding.

The community-based seed system (CBSS) uses a wide diversity in agriculture to address the needs and priorities of smallholder farmers in marginal areas. It is a

participatory farmer-led holistic approach. It has the ability to combine the informal and formal seed systems if given enough support because it deals with all of the local crops and commodities, including improved local varieties, neglected and underused species (NUS), and future smart food crops.

By utilizing and promoting rich agrobiodiversity, participatory crop improvement, community biodiversity management, community seed banks, strategic partnership development with public and private sectors, as well as policy support for their recognition and harmonization, CBSS can be improved to be more inclusive, pluralistic, and dynamic.

Agriculture development is largely dependent on farmers having access to high-quality seeds that have characteristics that match the regional environment and market expectations. Farmers may favor regional diversity over monocultures of high-yielding varieties and cultivate a mix of robust, regional crop varieties that are chosen for qualities like pest resistance or drought tolerance, as well as for a particular regional cuisine. This varied strategy protects against dangers related to biology or the climate.

For farmers to adapt to climate change, local seed systems must be improved. The "area appropriateness" of species and varieties may alter significantly in a scenario of climate change and fluctuation. Beyond the social seed networks of today, seeds will need to be transported across longer distances. The necessity for immediate preparation for such transformations might

(b) **On-farm conservation and management of agrobiodiversity** presents a deeper understanding of how farmers conserve and manage agrobiodiversity on farms and of the related challenges and opportunities.

To meet daily demands and ensure long-term sustainability in the global food and agricultural sectors, agricultural biodiversity is of utmost importance. The availability of genetic variety serves as the foundation for scientific study to develop various varieties, methodologies, and procedures that are appropriate for various

agroecologies. Agriculture's biodiversity has been conserved by farmers for generations.

A wide variety of local breeds and landraces that are crucial components of the gene pools of agricultural species have been domesticated by farmers. On-farm conservation is described as "the ongoing cultivation and control by farmers in the agroecosystem where a crop has evolved of a diversified set of populations." Therefore, ongoing on-farm conservation and management are necessary for a species' continual evolution and adaptation, including adaptation to climate change. The role of farmers as stewards of agrobiodiversity and the local knowledge about this diversity needs to be better understood, supported, and rewarded. However, in contemporary agriculture, crop and livestock production systems have specialized more and frequently divide massive, specialized, energy-intensive farming operations.

(c) **Value chains of neglected and underutilized species (NUS)** presents an approach to improving farmers' gainful participation in markets, looking at a broad range of issues 'from farm to fork'.

The livelihoods of rural poor people depend heavily on agro-biodiversity in many traditional farming systems around the world. It is well known that incorporating the use of NUS into the traditional household systems of resource-poor people—whether they be small-scale farmers or collectors—holds significant potential for:

Environmental benefits include biodiversity preservation and stabilizing agro-ecosystems; Social benefits include enhancing food security and achieving more balanced nutrition for the rural and urban poor; and Other benefits include providing income for the rural poor and generating employment along the value chain (VC) (economic benefits).

Integration opportunities/requirements

Agrobiodiversity can be used sustainably in agricultural land use systems such as crop production, animal rearing, horticultural crop promotion, and pasture-land management.

Identify suitable crops and varieties for any given production system

Main purpose/ core deliverables

The importance of improve genetic diversity is

- Playing a key role in the continuation of agricultural development with significant improvement in different morphological and agronomical characteristics.

As the genetic diversity increases the ability to adapt to changing environments also increases within a given species.

Suitability and adaptability to local knowledge

Genetic diversity for crowdsourcing enables for the development of high yields of farmers and breeders preferred improved quality cultivars. Genetic diversity also playing paramount role towards the development of potential varieties against new diseases, insect pests, extreme heat and extreme cold.

The degree of genetic variety among crop species that can be used in an improvement program. The effectiveness of a breeding program is largely dependent on the presence of adequate genetic diversity. The evolution of superior variations with regard to yield and other desirable features depends largely on genetic diversity. The creation of excellent hybrids and desirable recombinants also heavily depends on it.

The efficiency and effectiveness of improvements that could lead to increased food production are determined by genetic diversity. From the perspective of plant breeding, the differentiation of genetic diversity into the appropriate heterotic group is essential for the creation of robust and exceptional hybrids in terms of economically significant features. Genetic diversity is providing vital protection to other nature against climate change, pests and diseases stresses.

Traditional farming practices have a vast genetic diversity that is a result of human experimentation and invention, as well as historical indigenous knowledge and ongoing biodiversity change.

Thus, it makes a lot of sense to use traditional crops and outstanding farmer varieties. Together, farmers, extension and development specialists, and scientists can optimize the advantages of this diversity and jointly comprehend its significance. Farmers have

knowledge about crops and kinds that could have received little investigation but may still have significant nutritional or therapeutic value, offering the possibility of income-generating activities. Development agents can help make certain crops and kinds more well-known, and scientists can learn more about crops that haven't been thoroughly studied.

Main land use and agro ecology

There are specific crops and varieties that can be grown in each agro-ecology and farm with the potential to increase production and resilience as well as open up new avenues for generating income.

Potential to increase/sustain productivity and environmental protection (impacts)

This evaluation will allow for the establishment of two potential impacts:

1. Selection of the best crop varieties to increase productivity and hardiness

2. To find crops and species that could improve human nutrition and health as well as create new opportunities for income. For instance, if a landrace is discovered to have significant nutritional value, it may be developed into a brand-new source of income.

Description of the technology and steps

Participatory traits and variety identification

This technology aims at identifying crops and verities with high potential to contribute to food security and livelihood. The technology also aims at providing development agents and extension workers with greater insights about diversity and its potential contribution to livelihood.

The technology is very simple to apply but it requires some skills to allow the implementing team to properly interact with the farmers and representative of the communities. As this can be considered a participatory approach it is important to understand some simple rules. It is important to understand that in this exercise the scope is to learn from the community which resources they have that may enhance food security and create additional opportunities for income generation. This implies that the facilitator needs to have a disposition to be self-reflective, question his/her own assumptions, ‘unlearn’ and

embrace local knowledge and listen to local voices rather than trying to push a predetermined agenda. The challenge is to facilitate participatory workshops in a way that does not impose a certain opinion on participants or that influences the process to reach certain results. This tool kit provides some ways to understand the local context and people's perception on the provision and use of health services for children and women, but obtaining some useful results depends ultimately on people's participation. Hence, it is crucial that the facilitator establishes a relationship of trust and creates a space, which is inclusive and where people feel at ease to express their opinions. Here are some key principles for participatory approaches.

Participation

That all people have a right to play an active and influential part in shaping decisions that affect them sounds obvious, but genuine participation is not easy to achieve. It means that views and opinions are not just listened to but heard and acted upon. There are different types of participatory interaction.

Seeking and valuing local knowledge

Local people have their own expert knowledge of their area: this should be the starting point for organisations working with them. Within the community there will be differing perspectives and "realities" – every person has their own experiences and interpretations which add richness and value to a process.

Using a mixture of visual and verbal techniques

A mix of methods aims to make processes as inclusive as possible. Through diagrams, drawings and sharing experiences, the aim is to involve as many people as possible. The process aims to be on an equal basis, regardless of age, race, gender, culture, literacy level, social or economic status. Methods should be used in ways that make people comfortable, and encourages them to voice their opinions and be heard.

Actively seeking unheard voices

Participatory approaches involve trying to ensure that people who are normally silent or silenced are granted safe spaces to be heard. It is often those that have least say in decisions affecting their lives that are most affected by them. This often includes women,

youth, the elderly, geographically remote people, poorer people, those that cannot read, migrants, and those with disabilities. Facilitating participatory approaches means actively trying to find out who wants to participate but is currently excluded, and then trying to include them. The approach also respects that some people may not want to take part! Care needs to be taken about how power relations will affect those who are often suppressed or silent when the project and outsiders have left.

A reversal of learning

These approaches are about outsiders learning from the community, gaining their wisdom and letting go of preconceptions. It may also involve "unlearning" what the outsiders think they already know.

Handing over the stick (or pen, or chalk)

This phrase came from early participatory work and is essentially about letting others "do it". It involves those considered expert or powerful or of higher status sitting back, keeping quiet and letting the community get on with it. The terms "uppers" and "lowers" are often used in the context of participatory approaches: thinking about the relationships between them and their implications in terms of power, willingness to speak etc. is an important consideration. (Adapted from Stevens, 2011; HIV/AIDS Alliance, 2006).

In order to understand the diversity it is necessary to engage with a group of 6 to 8 male farmers and 6 to 8 female farmers. The facilitators need to come with big piece of paper, pens, post-its, board, flipchart.

When farmers are coming together, the facilitator will:

1. **Introducing the exercise**

The facilitator introduces him/herself and explains the objective of the exercise. If there are two facilitators available, the group of people is divided into a group of men and a group of women, who will ideally be in separate rooms. The following steps are the same for the two groups.

2. **Brainstorming about different components of agricultural biodiversity**

The facilitator lists in a flipchart the crops (including fruit trees and vegetables as they are mentioned by the farmers, cultivated and in the wild) and asks participants for what reason

they are used locally. It is important to also use the local names of crops when listing them. The participants are asked to rank the species/crop based on the importance for food security/nutrition/livelihood and to add positive as well as negative feature for each crop. The facilitators also asks whether the crops are common or not and whether they are cultivated or found from the wild.

On a separate flipchart the facilitators ask the same questions for livestock in all its components including type of livestock and breed and positive and negative feature for each.

3. **Identify varieties for major staple crops (max for 2 crops)**

On a separate flipchart the facilitators the 2 most important crops in the area and ask participants to indicate the varieties for each crop and whether they are improved or traditional. The facilitator will generate a table as the one below.

Wheat	
Name of Variety	**Type of variety**
A	Improved
B	Traditional
C	Improved
D	Traditional

4. **Identify traits that are relevant for each crop**

On the same flipchart the facilitators ask which traits are important for the crops. This can include agronomic traits, yield, biomass, resistance to pests and diseases etc, quality traits, such as taste cookability etc and ask the farmers to score each trait against each variety from 1 to 5 way so that 5 is very good performance for that trait and 1 is very poor. Finally the enumerator will add an overall column for a general scoring of each variety. At the end of this step the enumerators will have a table like this.

Wheat						
Name of Variety	**Type of variety**	**Trait 1**	**Trait 2**	**Trait 3**	**Trait 4**	**Overall**
A	Improved	3	2	4	4	3
B	Traditional	2	4	3	5	4
C	Improved	1	5	4	2	4
D	Traditional	4	4	5	4	5

5. Identifying lost varieties

Finally, the enumerators ask the farmers if they know other varieties that are no longer cultivated in the watershed. If Yes, what are the names of these to be added at the bottom of the previous table and why they are no longer grown.

The final table will look like this:

Wheat						
Name of Variety	**Type of variety**	**Trait 1**	**Trait 2**	**Trait 3**	**Trait 4**	**Overall**
A	Improved	3	2	4	4	3
B	Traditional	2	4	3	5	4
C	Improved	1	5	4	2	4
D	Traditional	4	4	5	4	5
Lost Varieties						Reasons for loosing
X	Traditional					Notes

Y	Traditional					Notes

Test the identified varieties with farmers using diversity blocks

Main purpose/ core deliverables

Diversity block is an experimental block of varieties managed by local institution for research and development purposes (e.g. farmers' training centres). The block is not only used for measuring and analysing agro-morphological characteristics but also used to allow farmers to evaluate the varieties and assess their preferences. Diversity block also has the additional advantage of raising public awareness. Planting materials can be multiplied for further distribution to farmers who may request some specific varieties. In case material from other areas or from the national genebank is also tested in diversity blocks, than the diversity block is also a way to expose farmers to this new set of diverse material with traits for potential adaptation to climate change. Finally, the diversity blocks can serve to sensitize local community on the value of community managed biodiversity and create ownership of diversity.

Suitability and adaptability to local knowledge

Diversified agriculture is the existing and well known risk management strategy of Ethiopian farmers, and it is believed to be one of the cross cutting component to be incorporated in all system of climate smart agriculture.

Main land use and agro ecology

Diversified agriculture can be implemented in all agro-ecologies where there are agricultural practices and is one key climate smart activity. Selection and promotion of superior varieties of any given crop can be enabled under any climatic or soil conditions. In addition, it can be fully integrated with any other climate smart practices related to soil fertility management and most likely it will enhance productivity under those management practices compared to conventional varieties. Evidence from Ethiopia show that productivity can be enhanced two fold under marginal conditions in Tigray, Amhara and Oromia when using superior and well adapted varieties to local environmental and soil

conditions. In addition, these superior varieties tend to have greater resistance to major diseases such as rust and therefore contribute to minimize the use of fungicides. When grown in mixtures this effect can be further emphasized.

The identification of such superior varieties, however, requires at the initial stage a strong collaboration between research and the extension systems. It is therefore essential, unless superior varieties are already identified, to engage with zonal/regional research centers.

Potential to increase/sustain productivity and environmental protection (impacts)

The diversity blocks are an essential part of the biodiversity based approach as they are the way through which new varieties with better performance can be delivered to the farmers. It is therefore through diversity blocks that the performance of varieties can be assessed and farmers can become familiar with them. In addition, they will allow testing adaptation of different varieties to different environmental and climatic conditions.

Description of the technology and steps

The following steps and processes are required to establish a functional Diversity Block.

Step 1

Collect seed samples (50-200g seed per variety depending upon crop) during a community meeting. The collected varieties will be based upon the diversity assessment and should include passport data, including the name of the variety, farmers' descriptor, names of farmers who provided the seeds, altitude, name of locality. The seeds shall include both modern and farmers' varieties. Additional varieties shall be collected from other sources such as the National Gene Bank in order to enhance the diversity available to the farmers.

Step 2

Complement the information acquired with additional number of varieties from the national gene bank. Ideally a total number of 20-30 varieties should compose a diversity block and therefore the number of additional varieties depend on the number of locally available varieties,

Step 3

Reiterate objectives and potential benefits from the diversity block and discuss in the community to identify interested local institutions to grow and maintain a diversity block at

a strategic public place and representative domain. Ideally farmers' training centers are to be selected or, in alternative, the nearest research centre.

Step 4

Orient community members for simple field layout, planting and labelling and identify a focal person for management of the block. It is essential to provide conceptual and practical training to ensure proper management of the field. Collaboration with nearest research centre may be of great value.

Step 5

Grow available diversity of the crop under standard recommended management system for the crops. Make sure each variety is properly labeled to avoid confusion and mixing up of varieties. Ensure that standard agromorpholigical traits (depending on the crop) are measured following standard procedure .

Step 6

Conduct a field day with interested and knowledgeable farmers, researchers and development agents in order to:

- promote proper farmers evaluation of the varieties displayed in the diversity block;
- collect demand for seed for future planting
- Make sure farmers' preferences are properly captured and reasons for choice are properly noted, ideally male and female farmers' should evaluate varieties in separate groups.
- Reseachers may identify varieties useful for inclusion in breeding programs and can better understand farmers' preferences,

Step 7

Harvest seed and store seed in safe and proper environment, avoid seed contamination (harvest 1 block at a time) and prevent seeds attack by insects.

Step 8

Update the database of the community biodiversity register to encourage participants for on-farm conservation and to support landrace enhancement. Make sure all information are available to the community

Validate varieties and enhance availability by distributing them through crowdsourcing approaches

Main purpose/ core deliverables

- The world is affected by climate change and consequently affecting agricultural productivity, that led farmers to be unsecured and vulnerable. The bad thing about climate change is its unpredictability. Therefore, diversifying agriculture at species/variety level will secure farmers from the total loss of harvest.
- Crowd sourcing approach uses multiple superior varieties (genotypes) that are tested by the community themselves after selection from diversity block as best in bad season and others best in good season. Then since the climate is unpredictable, when the season is bad the farmer will harvest genotype that suits bad condition and if the season is good, he/she will have a chance to get premium production from all genotypes. Therefore, diversifying varieties/genotypes is a means for food security at household level sustainably. These tools will enable to reach large farmers in few resources in short period of time.
- Using diversified genotypes and/or species is also help farmers to be resilient from sporadic outbreak of diseases and pests. Since the genetic makeup of different genotypes and species is different, they will not be attacked by one time appearing disease or pest race all at the same time.

Suitability and adaptability to local knowledge

The use of crowdsourcing approaches is strongly tied to traditional knowledge. The farmer-preferred varieties identified in the previous step are distributed to farmers in small batches and tested under their own management practices and soil conditions. A big advantage of this approach is that growers can test varieties throughout the growing

season and not just for one day. So they can really appreciate the seed's potential for uses that are important to them. , they can truly understand them.

This approach makes it possible to reach out to a larger number of farmers and involve them fully in the assessment compared to traditional approaches. The costs to farmers are much lower because the extension or research system does not have to administer the trials themselves.

Main land use and agro ecology

There are specific crops and varieties that can be employed in each area and agro-ecology to increase production and resilience as well as offer new opportunities for a livelihood. Although using diverse crops, the crowdsourcing approach is appropriate for all agroecologies and soil types.

Potential to increase/sustain productivity and environmental protection (impacts)

The necessity to offer farmers with a variety of crop species and varieties to enable them cope with environmental restrictions in a changing climate by matching varieties to varied production conditions and weather extremes is what spurs variety introduction activities. Varieties distributed to farmers using a crowdsourcing approach have been pre-selected from diversity blocks and are therefore those with high productivity. As in the diversity blocks all varieties are included it is assumed that the one passing that stage are superior to the existing ones.

Description of the technology and steps

The application of diversity agriculture in conjunction with other technologies is possible. A tricot plot design can be used as a manner of demonstrating and scaling out a crowdsourcing approach to rich an infinite number of farmers quickly.

Diversity agriculture can be integrally used with other technologies. As a way of demonstration and scaling up a crowdsourcing approach can be used to rich uncountable number of farmers in short period. Bioversity international is adopting this approach in different countries in the world including Ethiopia. As per the research conducted by Bioversity international in collaboration with Amhara region agricultural research institute (ARARI), Mekelle university, Ethiopian biodiversity institute (EBI), and Ethiopian Institute of

Agriculture Research, farmers in different villages were adopting different superior genotypes best fitted to their localities and based on climate prediction and their house hold needs. In most cases farmers varieties (Landraces) were the superior genotypes in terms of yield and largely preferred by farmers. The approach can be used also for dissemination of improved seeds or other technologies. The idea is that farmers should receive superior varieties and if farmers' varieties are superior, they need to be made available to farmers.

Steps in implementation of crowdsourcing

1. Component Identification

   Select varieties from diversity blocks.

   Select varieties/genotypes which are being produced by farmers and/or genotypes being produced in other localities that might be believed or identified to suite to such similar areas and farming system.

   The genotype components should have different genotypic makeup to react differently for the environment they will face within the watershed.
2. Identify farmers who are receiving different composition of varieties.
3. Seed preparation

   Seeds of two or more varieties or species can be prepared separately if the farmer plan to saw it in a separate plot of land.

   Case: from Bioversity international crowd sourcing experiment, farmers were provided four different random varieties from the total of 21 varieties distributed all over in the community.
4. Site selection and planting

   Crop rotation should be considered whenever a farmer need to select sites.

   It can be planted separately in the farmer field (as stated in bullet 3). If the farmer has experience in mixing different varieties, it is also possible to mix all together considering the maturity dates of these varieties in order not to face difficulty during harvesting.

Figure. Land preparation and fertilizer application

5. Cultivation

   Apply cultural practice and local management practices of cultivation, fertilization (manure and compost) and weeding as recommended for that specific crop species in that specific locality.

6. Measurements

   Let farmers to take their own measurement and deep understanding about the varieties and the climate condition of that specific season, it will help farmers to select varieties for future.

Figure: measurement of durum wheat landraces in farmers field

7. Harvesting

   Harvesting can be done by hand using equipment. And let farmers to provide the seed at least for five other farmers in the next season to insure the availability of these varieties within the community and to change the diversity of varieties in that locality.

It is important that development agents follow the farmers throughout the process and advise them as part of their regular activities. In this way they can co-learn with farmers how varieties perform in different soils and micro-ecologies.

Enhance social capital by establishing community seed bank.

Main purpose/ core deliverables

The genetic base of traditional seed varieties reduced considerably and several traditional seed varieties are now facing extinction. These varieties were inherently more compatible with local farming conditions, economically practical and environmentally sustainable than the high yielding varieties being used today. Additionally, they had higher resistance to pests, illnesses, droughts, and floods. Therefore, Community Seed Banks (CSB) are utilized

to store and make sure that smallholder farmers in need have access to the necessary seeds and other farm inputs.

The community seed bank renews the planting material that can be stored there and collects seeds from farmers in the adjacent villages to give variety. In order to maintain a consistent supply of seed, farmers who borrow seeds from the communal seed bank must repay twice as much after harvest. Each farmer receives training in seed production and management in order to ensure that the seed received by the community seed bank is of the best quality.

Suitability and adaptability to local knowledge

Community seed bank development is also important for sustainable diversity and nutritional improvement and for conscientious use of crowdsourcing approach. Community Seed Banks (CSBs) are village-based organizations run by smallholder farmers with the goal of ensuring the production and distribution of high-quality seeds within the community. Smaller populations living in agro-ecological niches connected by migration and household colonization of seed make up this informal and open system.

Main use and objectives

Five functions of the local seed bank include:

1. preserving seeds of local bean varieties in-situ;
2. assisting in the development of farmers' and communities' capacity to produce high-quality seed;
3. multiplying seeds of local varieties that are rare and distinctive or that are becoming less accessible to farmers and making them available every season;
4. evaluating a variety of materials for various functional traits, such as early maturity or drought tolerance; and
5. Providing a variety of high-quality seeds with a range of functional traits.

Clearly a community seed bank can be established in all sites as they build and depend on local resources.

Potential to increase/sustain productivity and environmental protection (impacts)

Community seed banks provide the seeds of farmers' preferred varieties. However, for that to be possible they need to become a reliable source of seeds for the community.

Description of the technology and steps

The three tasks that a community seed bank typically carries out are as follows:

- Preserve local varieties and revive those that have vanished from the area.
- Provide access to good quality seeds and make them readily available at a low cost to farmers who are interested in or in need of seed.
- Act as a base for community development.

Here are four realistic steps you may take to start your own community seed bank.

- Evaluating crop diversity and increasing public awareness

Assessing the diversity of local crops, looking closely at the current seed system, doing a trend analysis, and promoting awareness are the four tasks that make up this initial stage.

- Choosing to start a neighborhood seed bank

Following the process of raising awareness, some local farmers may take the initiative to persuade the neighborhood to create a community seed bank.

- Creating a community seed bank and inspiring and uniting farmers

Organizations that assist the creation of community seed banks frequently request a contribution in kind from the local population. Farmers must be encouraged to contribute their labor to this community project.

- Planning a training

It will be advantageous to have training in seed picking, washing, drying, storing, and documenting. It will be wise to get in touch with the neighborhood extension agent and request assistance in planning specialized training. Some community seed banks work along with a local farmers' field school to provide training and teach people how to gather and multiply seeds in an effective and efficient manner.

Popularize and share diversity within the community through diversity fairs.

Main purpose/ core deliverables

The diversity fair helps:

- To examine, display, and record current inter- and intra-specific crop diversity.
- To investigate and find uncommon and distinctive local crop variations
- To identify smallholder farmers, certain neighbourhoods, and hotspot regions
- To encourage the sharing of knowledge and genetic material. To inspire local businesses or organizations to take action.
- To promote publications or messages that will increase awareness and sensibility
- To raise awareness of, and provide policy makers with information about, the benefits of agricultural biodiversity

Suitability and adaptability to local knowledge

The Diversity Fair (DF) is a well-established, multipurpose and participatory tool designed to raise awareness among communities and various stakeholders about the importance and value of local genetic resources. It is crucial for sustainability of crowdsourcing approach. A DF is sometimes called a seed fair when the community focuses solely on displaying seeds and planting materials. DF is recognized as an effective tool to facilitate on-farm and on-site conservation of local crops (Sthapit et al. 2006).

Although DF can be organized by any community-based organizations, development agencies, local governments, etc., technical facilitation or expert assistance is a need. Before making a choice, the organizers should be clear on why they are planning to have the DF in order to justify its relevance, which can help to create a sense of shared ownership and knowledge of the entire event. In order to maximize the use of local resources and make DF more meaningful and cost-effective, community participation is essential at every stage.

Diversity fairs encourage local seed exchanges and information sharing among farmers as a way to give local farmers access to more varieties and sustain higher levels of biodiversity. In order to encourage local communities to maintain high crop diversity and bring in uncommon and distinctive diversity for display, it is frequently staged as a competitive event. Researchers and development specialists should take advantage of this chance to

locate the custodians and learn more about traditional knowledge. In essence, it serves as a forum for participants in the fair to exchange and discuss traditional knowledge.

Potential to increase/sustain productivity and environmental protection (impacts)

Farmers from many communities within a watershed exchange seeds and knowledge at diversity fairs. Consequently, it is a chance to obtain seeds of better adapted types from other farmers in a different community and a chance to test them in various environments. Additionally, researchers and extension agents are welcome to the fair and can provide farmers extra advice on how to manage particular types. Due to all of this, the diversity expo offers a chance to learn more about ways to boost productivity.

Description of the technology and steps

Community-based organizations, development agencies, local governments, etc., are able to organize DF, but expert technical facilitation or assistance is a requirement.

The steps to be followed while organizing a diversity fair are as follows:

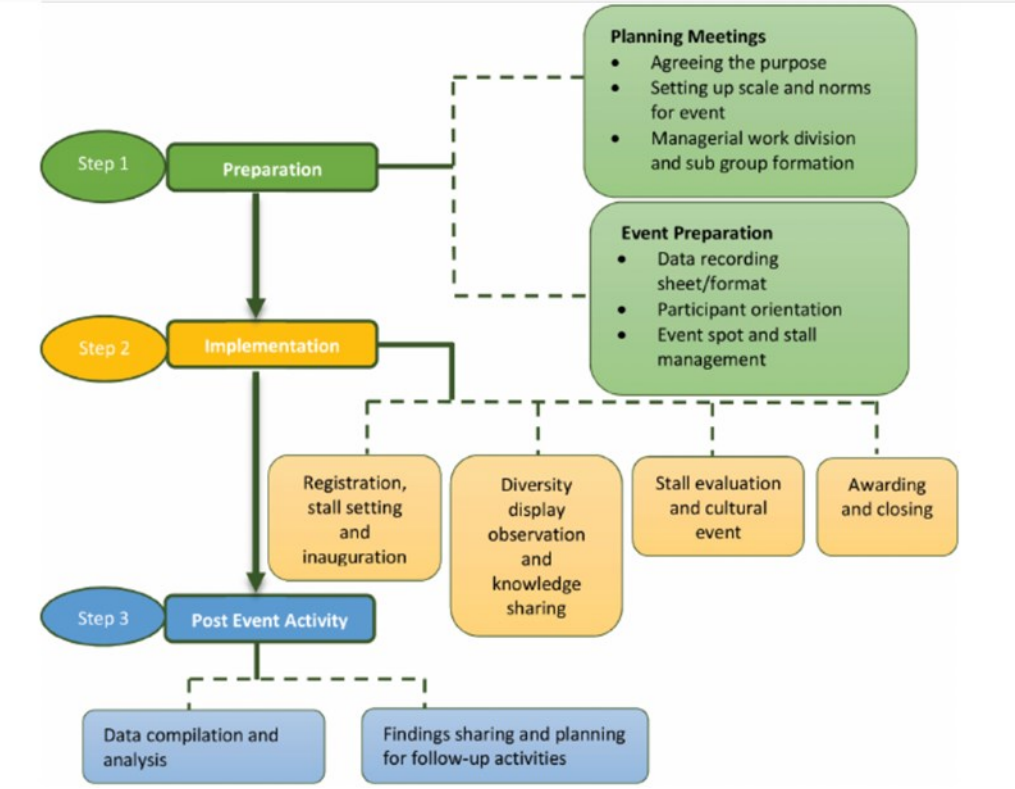

Figure. Steps of DF implementation procedures (Sources: Joshi BK. Et al., 2020)

Post-assessment

1. How agrobiodiversity can nourish the planet?
2. What is diversity fair and discus the importance of diversity fair for sustainable crop production?
3. What is crowdsourcing and why is it important?

Participatory Breeding/crop improvement

In order to increase the productivity of a certain crop, there is always a need to improve varieties based on the need of the farmers and climate. The main target of breeding programs should be satisfaction of their clients, especially farmers (*Kidane et. al., 2017*). A breeding product that do not have farmers trait of preference would end up with low adaptability. Considering the failure of adaptation in most of the countries, Bioversity international implements a scheme where all clients are participating from the beginning (Kidane et. al., 2019). This participatory breeding scheme involves farmers from trait identification to product evaluation. Since the need in different community and agro-ecology is varied, one can't have a single or two solutions to address. Therefore, our breeding scheme involve male, female, youth, and old farming communities independently to identify traits to be focused before the setup of the breeding block. Moreover, varieties are also to be identified and if possible, collected with farmers. This includes improved, traditional varieties and landraces from gene banks. Afterwards, these distantly related genotypes will be crossed together with a local research center where farmers have a chance to see the process. Once the genetic stability of the recombinant inbreed lines (RILs) attained, the next step will be exposing these RILs to different agroecologies and farmers thought. As it is mentioned above in this document, farmers will evaluate these RILs first in diversity block and then using crowdsourcing methodologies. By doing so it will be possible to achieve the needs of farmers in different agro-ecologies and minimize the risk of climate change.

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