# Study to assess and recommend how the role of marginalized groups (with a focus on women, youth, and Indigenous groups) in the smallholder farming sector can be strengthened in the *ex situ* conservation of PGRFA

## Final study report

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November 2022

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## Abbreviations

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| **ABC** | Alliance of Bioversity and CIAT |
| **AfricaRice** | Africa Rice Center |
| **ARI** | Agricultural Research Institute |
| **Bioversity** | Bioversity International, now ABC |
| **CGIAR** | Consortium of International Agricultural Research Centers |
| **CIAT** | International Center for Tropical Agriculture |
| **CIMMYT** | International Maize and Wheat Improvement Center |
| **CIP** | International Potato Center |
| **Crop Trust** | The Global Crop Diversity Trust |
| **CSA** | Climate-smart agriculture |
| **CWR** | Crop Wild Relatives |
| **FAO** | Food and Agriculture Organization |
| **GENESYS** | A platform that allows users to explore the world's crop diversity conserved in genebanks through a single website, helping them identify and acquire seeds that meet their needs and connect them to relevant genebanks |
| **GIZ** | Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH |
| **IARC** | International Agricultural Research Centers |
| **ICARDA** | International Center for Agricultural Research in Dry Areas |
| **ICRISAT** | International Crops Research Institute for the Semi-arid Tropics |
| **IITA** | International Institute of Tropical Agriculture |
| **ILRI** | International Livestock Research Institute |
| **IRRI** | International Rice Research Institute |
| **ITPGRFA** | International Treaty on Plant Genetic Resources for Food and Agriculture |
| **NAGRC** | National Agriculture Genetic Resource Center |
| **NARS** | National Agriculture Research System |
| **NGO** | Non-governmental Organization |
| **PGRFA** | Plant Genetic Resources for Food and Agriculture |
| **PPB** | Participatory Plant Breeding |
| **SINGER** | System-Wide Information System for Genetic Resources |
| **USAID** | United States Agency for International Development |

## Acknowledgements

First and foremost, I would like to thank my colleague Annika Napier-Smith for supporting me in this assignment. Annika contributed to the literature and desk research, study writing, and editing. Furthermore, she organized the interviews and was an important partner throughout the development of this study.

This study was written as part of the project ‘Strategic Development of the Crop Trust’, implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Global Crop Diversity Trust (Crop Trust). HFFA Research GmbH was commissioned by GIZ to write this study (project number 20.0125.3-001.00). Therefore, we would like to thank GIZ staff who supported us during this work. Further, we would like to thank Crop Trust staff for their support during the research and writing for this study. We would also like to thank all interview partners for their time and openness, as well as the insights and information they gave us. The interviews were indispensable for the research.

# 1. Introduction

Despite national and international commitments to achieve food security, as many as 828 million people suffered from hunger in 2021 (WHO 2022) and the global COVID-19 pandemic has exacerbated this situation further. Seeds are a fundamental element of agricultural systems as well as the socio-cultural systems surrounding them. The availability and use of a diverse set of plant genetic resources for food and agriculture (PGRFA)[1] are crucial for seed and food security. The availability of PGRFA depends on the seed systems used by farmers and their means to access them. Broadly speaking, PGRFA can be conserved on farmers' fields (*in situ*), in gene or seedbanks (*ex situ*) or dynamically combining both approaches. All forms of conservation are important for safeguarding and adapting seeds in the long run. Currently there exists more diversity of some crops *ex situ* than *in situ* in the crop's original center of diversity (Halewood 2013). This shows the importance of collecting and conserving material *ex situ* so that it is safeguarded and might be used in the future. Apart from the varieties and landraces currently used by farmers and other users, a great number of other accessions are held *ex situ* and their potential value can therefore be only determined in the future.

Nevertheless, Raeburn (1995) claimed that genebanks are seed 'morgues" and therefore have marginal value (Raeburn 1995). At the same time, scientists have begun to discuss a complementary and dynamic model of *ex situ* and *in situ* conservation, where both conservation types are combined, making it so farmers also participate in the process (Meng et al. 1998; Bellon et al. 1997; Berthaud 1997; Maxted et al. 1997; Ortega-Álvarez 1997). The approach is increasingly being promoted and accepted. For example, repatriation or rematriation programs by genebanks within the Consultative Group on International Agricultural Research (CGIAR) have implemented it for decades. National genebanks, for example in Ethiopia and Zimbabwe, facilitate a strong farmer-focused system of conservation and maintain close contact with farmers, community seedbanks, and non-governmental organizations (NGOs) (ISSD 2021). Further, many advances have been made in storage and regeneration techniques used by genebanks to support this combined method of conservation (Dulloo 2021).

Smallholder farmers are increasingly affected by interconnected ecological and economic changes at national and international levels (Gatzweiler and Braun 2016), as well as cultural changes that affect their livelihood and food production. It is criticized that the progress in reaching the poorest and most marginalized groups has been slow thus far, allowing rural poverty to persist and large potentials untapped (Gatzweiler and Braun 2016). Therefore, efforts must be made to reach these marginalized groups regarding PGRFA now and in the future, especially as smallholder farmers have significantly contributed genetic resources to the material stored in *ex situ* collections. According to recent statistics, genebanks in turn give only a small portion of their external distributions to farmers. For example, between 2017 and 2021 the international genebanks within the CGIAR system gave, on average, 8 % of their external distributions to farmers, farmer organizations, and NGOs (CGIAR 2022a). This again furthers the question of what genebanks have the capacity to distribute directly to farmers and marginalized groups, and what are other possible avenues for inclusion, for example through national genebanks, extension services, and NGOs.

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[1] According to the Food and Agriculture Organization (FAO) (2009a) PGRFA are '[…] any genetic material of plant origin of actual or potential value for food and agriculture".

The roles of international, regional, and national genebanks differ greatly in the degree to which they consider marginalized groups, and to say that only national genebanks have the capacity to work directly with them, or that international genebanks do not, is too simplified. Rather, this study explores the various opportunities all institutions of *ex situ* conservation have to address the needs and priorities of marginalized groups, through directed conservation and programming efforts, as well as direct and indirect forms of interaction and inclusion. For example, orphan crops are locally critical for rural, smallholder farmers, but given less attention at a global scale. By catering to their conservation, orphan crops could be sustained and evolved to better meet the needs of marginalized communities.

PGRFA users, and those accessing *ex situ* collections around the world, make up a very heterogenous group with different cultural, educational, economic, and agronomic backgrounds, ranging from professional plant breeders and pre-breeding researchers to farmers, or horticulturalists with different land and financial endowments. Even the categories listed here are very heterogenous and should be further differentiated when analyzing a specific user group. While acknowledging that there are many different PGRFA users with many different needs and roles, this study will focus on women, youth, and Indigenous persons as marginalized groups.

The state of research, and the necessity to conserve PGRFA for food security and general livelihoods, along with the desire to better include the needs and priorities of marginalized groups, shows that it is important to ask what role marginalized groups play in *ex situ* conservation of PGRFA and further, how this role can be strengthened. Therefore, this study investigates the following two research questions:

- What is the role of marginalized groups in *ex situ* conservation of PGRFA?
- And how can this role be strengthened?

Investigating these two questions will help to determine how genebanks can address the needs of groups that are not always automatically taken into consideration when setting the priorities for *ex situ* conservation and also how genebanks can better take into account the priorities and needs of these marginalized groups regarding the use, management and conservation of crop biodiversity. These research questions were investigated by looking at a sample of *ex situ* conservation institutions and PGRFA initiatives. Based on expert interviews as well as literature and desk research, this analysis explores the needs and priorities of marginalized groups with respect to PGRFA and how institutions of *ex situ* conservation currently integrate these in their activities and strategies. Further, this study discusses how genebank activities can be more inclusive to ultimately improve food security, climate change adaptation, and diversity conservation in the future.

Therefore, the conceptual framework and methods used in this study are first presented (chapter 2). An important part of this chapter is the elaboration on what the term ‘marginalized groups” means in the context of using and conserving PGRFA (2.1) and then the methods are described (2.2). The third chapter provides details on the role of marginalized groups in *ex situ* conservation of PGRFA. This chapter first explains how marginalized groups use and conserve PGRFA, and their respective needs in relation to PGRFA conservation and use (3.1). The next sub-chapter (3.2) elaborates on resources and activities by institutions of *ex situ* conservation which can connect them with marginalized groups and are useful to them. Section 3.3. assesses how inclusive *ex situ* conservation institutions are presently, focusing on international and national genebanks as well as community seedbanks. Chapter 4 presents selected examples of best practices (4.1), lessons-learnt (4.2), and recommendations with actionable activities (4.3). The study finishes with a summary and conclusion summarizing the study's results and setting them in the broader research context (5).

## 2. Conceptual Frame and Methods

Chapter 2 describes the concept of marginalized groups for the context of this study (section 2.1), explains important institutions and systems of PGRFA conservation (section 2.2) and further gives details on the methods used to answer the research questions (section 2.3).

### 2.1. Concept of marginalized groups

In conducting this study, it was important to determine a working concept or definition for marginalization. When determining this definition, it was important to examine which groups are typically not taken into consideration when setting priorities in *ex situ* conservation. At a farming level for example, men and women contribute differently to the conservation and sustainable management of biodiversity, experience climate change impacts differently, as well as have differing needs and interests. Therefore, it is important to thoroughly consider all of the factors that contribute not only to conservation, but also how different groups sustain their livelihoods and contribute to their families and communities. The terms for conducting this research also provided that 'marginalized groups' was meant to focus on women, youth, and Indigenous people. However, we found that to further explore how genebanks are integrating marginalized groups in their work, it is crucial to expand this definition. Inequality of access is a helpful starting point in developing a working concept of marginalized groups, but this inequality is compounded by different factors and is difficult to define concretely, as context, time, and locality are extremely relevant. Therefore, intersectionality plays a key role in defining and thinking about marginalization. Intersectionality is the idea that elements of inequality are intertwined and create unique dynamics of discrimination, and that by focusing solely on certain elements of inequality, other characteristics go unaddressed or even reinforce discrimination in a new way (Carbado et al. 2014). Intersectional analysis looks at the various categories that contribute to a person or group's identity, and how they interrelate and influence each other. Legal scholars continue to use intersectional analysis to highlight the weaknesses of many dominant legal approaches that confine discrimination to a single axis, which in turn ignores those who are effectively harmed by a combination of inequalities (Crenshaw 1989). Additionally, intersectional frameworks also have the potential to identify commonalities among people who are affected by similar dominations, whether that be gender discrimination, poverty, race, or several other factors (Roberts and Jesudason 2013).

The Fundamental Rights Agency defines marginalization as experienced discrimination due to an interplay of factors including gender, sex, age, ethnicity, religion, health, disability, sexual orientation, education or income, or various geographic locations (Fundamental Rights Agency 2022). Furthermore, in defining the concept of 'marginalized groups', inequalities in terms of access to resources, rights and use of services and goods in a variety of domains must be considered, for example in land, health, social and housing assistance, education, protection against domestic or institutional violence, and justice.

In the context of conservation and use of PGRFA and in the smallholder farming sector, marginalized groups are also termed underprivileged groups or socially differentiated groups defined as women, the poor and the Indigenous (Shaw and Kristjanson 2014). The FAO

(2022) defines marginalized groups as rural poor, Indigenous peoples, and smallholder families. As elaborated above, marginalization also depends on the specific time, place, context, and on the positions of power within certain structures under consideration. This means that people might be marginalized in a specific context, and not in others. Therefore, it is important to note that it is not possible to draw a general global recommendation on who is marginalized in *ex situ* conservation and access to PGRFA, because marginalization is contextually dependent.

Within the realm of this study the following characteristics have been identified which can lead (individually or in an interplay) to marginalization:

- Gender (Sikhu Okonya et al. 2019),
- Race, ethnicity, and Indigenous groups (Mollins 2019),
- Age or cultural initiations that 'define" one's role roles in society (Elias et al. 2018),
- Marital status and childbirth,
- Education, language, and literacy (Howard 2003),
- Social status (e.g., casts, classes, reputation),
- Economic status (e.g., wealth, household income, savings, market access),
- Status of security and migration (e.g., if a household is impacted by conflict, has been displaced or if household members cannot participate in agricultural work as they moved to find work elsewhere),
- Political participation and attitude,
- Wellbeing, health, body ableness, mobility constraints,
- Access to and control over land (FAO 2014; Mollins 2019),
- Religion and beliefs, kinship,
- Time and distance constraints (Puskur et al. 2021).

As the CGIAR genebanks are currently the largest and most frequently accessed network of global *ex situ* collections (Smale and Jamora 2020) and CGIAR works to create a food-secure future, an important objective for marginalized groups, we explore not only how CGIAR genebanks include marginalized groups, but also the definitions and concepts of CGIAR centers when they write about marginalized groups. There is no definition available by the CGIAR of who is marginalized. The definitions for marginalization in CGIAR programs and information is often implicit and can be understood in the context of program objectives. For example, in the ILRI (International Livestock Research Institute) brief ''Securing more income for marginalized communities in Tanzania through dairy market hubs', marginalization is defined as rural, poor, smallholder farmers (Twine and Omore 2016). However, the degree of programming and initiatives focused on gender, for example through the Gender Platform of the CGIAR, indicates a marginalization of women in the context of agriculture.

Additionally, 'gender and youth' initiatives indicate a grouping together of two very different marginalized groups, with the common characteristics of both being lack of access to land and resources (Girard et al. 2021). For example, the 'Seed Equal CGIAR' initiative focuses on 'smallholder farmers, women, and disadvantaged groups' (Barker 2018), and the CGIAR action strategy 'Community of Excellence for Seed System Development' focuses on 'developing-country farmers, and especially small-scale, resource-poor female and male farmers in those countries (IFPRI 2020). The context of a study or project title will also often imply the marginalized group as well, as the group that requires more focused outreach and attention. For example, a study by Bioversity International focuses on Indigenous knowledge, stating that it should be more used to find ways to improve agricultural production, but Indigenous people are often marginalized, and their knowledge is not accessed or appreciated (Nkhoma and Otieno 2017). This is all to say, there is not a clear definition provided by the CGIAR; but rather projects and initiatives to determine what the key social interests are for the various centers and the CGIAR as a whole.

Terms that were common in the literature or projects about marginalized groups were ‘rural’, ‘poor’, ‘vulnerable’, ‘women’, ‘Indigenous’, and ‘farmers’, often less explicitly but implied in the descriptions of the program participants. ‘Vulnerable’ was a term often used instead of marginalized, in the effort to emphasize the circumstances affecting a person or persons. On the other hand, the term ‘marginalized’ may be deemed outdated or simplified, as it emphasizes the ‘otherness’ of certain groups, as can be derived from the key word ‘margin’ meaning ‘the edge or border of something’ or ‘marginal’ meaning ‘excluded from or existing outside the mainstream of society’ (Merriam-Webster 2022).

All groups, however, are a sub-category of *smallholder farmer,* therefore we also use the term smallholder farmer to collectively refer to all types of marginalized groups irrespective of the specific context, time etc. In the context of this study marginalization means some combination of the defining factors described above, while recognizing that marginalization differs across sectors, cultures, regions, and time and is intersectional. Within groups defined as marginalized, large diversity exists; people belonging to a marginalized group are not homogenous.

## 2.2. Methods

The study was conducted by means of an intensive desk review and literature scoping, with exploratory interviews from members of the Global Crop Diversity Trust (Crop Trust) Science Team, and through systematizing expert interviews with representatives of *ex situ* conservation institutions, as well as a variety of relevant experts in PGRFA conservation and the social sciences.

The research began with intensive desk research reviewing annual reports, grey literature, and webpages published by institutions of *ex situ* conservation. This served to retrieve genebank projects and concepts within the broader realm of PGRFA conservation and use by marginalized groups and smallholder farmers. Further, it was important to elaborate on how and to what extent marginalized groups are included in projects of *ex situ* conservation. Additionally, literature research on the study’s research questions as well as the concepts and definitions of marginalized groups and their needs was conducted. All this helped to summarize and analyze the status quo of genebank inclusiveness and the role of marginalized groups in *ex situ* conservation. Further appropriate methods to elaborate the research questions were chosen based on this research.

This first literature scoping and desk review was supplemented with seven explorative (in-depth expert) interviews of Crop Trust Science Team members. These members were chosen as this study is intended to contribute to the project ‘Strategic Development of the Crop Trust”, implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and Crop Trust. Through these interviews, experiences, and concerns regarding marginalized groups and genebanks were identified. The desk and literature research, as well as the interviews with Crop Trust Science Team members, served to detect important aspects for the subsequent systematizing (in depth expert) interviews (van Audenhove and Donders 2019). Based on the first interviews as well as the desk and literature review, an interview guide was conceptualized to structure the 30 systematizing expert interviews. The guide provided a framework by which the interviews could be compared and analyzed.

Overall, eight CGIAR genebank heads, five heads of national genebanks, seven experts from NGOs or community seedbanks, and ten experts on gender, PGRFA conservation, and use, as well as other study aspects, were interviewed. Thereby the overlap between data collection and data analysis during the interviews was carefully chosen to explore a topic on which only scarce literature exists (van Audenhove and Donders 2019). These interviews as well as the desk and literature research were used to identify possible experts in the field. Experts were selected to include different actors and represent different points of view and fields (Johnson et al. 2004; Bogner et al. 2009).

# 3. Role of marginalized groups in *ex situ* conservation of plant genetic resources

This chapter will describe different aspects which form the role of marginalized groups in *ex situ* conservation. Section 3.1 explains how marginalized groups use and conserve PGRFA. Thereby, the general needs of marginalized groups. as well as needs of women, youth and Indigenous groups are summarized. Then, section 3.2 lists how institutions of *ex situ* conservation can work with marginalized groups and be inclusive. This section is divided in two parts, where the institutions of *ex situ* conservation are depicted as repositories of PGRFA and accompanying data, and also as distributors of material. The third part of this chapter (section 3.3) evaluates how inclusive international and national genebanks as well as community seedbanks are currently. All these elements form the role of marginalized groups in *ex situ* conservation and with increased inclusivity, genebanks can support marginalized groups in filling their potential role.

## 3.1. Use and conservation of plant genetic resources by marginalized groups

The following section summarizes a literature review conducted on PGRFA conservation and use relating to marginalized groups (with a focus on women, youth, and Indigenous people) in the smallholder farming sector. It synthesizes key findings and implications on how to strengthen their role in PGRFA conservation as well as the linkages between *ex situ* conservation and farmers' seed systems. The lessons-learnt and recommendations described in chapter 4 are based on this literature review as well as the expert interviews.

**The collective needs of marginalized groups**

The needs of marginalized groups which are a subset of smallholder farmers are vast and vary contextually, however the following needs regarding PGRFA are generalizable. Marginalized smallholder farmers need food and nutritional security, and for this to be achieved, many elements must be considered. Some of these include growing locally adapted, high yielding, resistant, tolerant, and nutritious cultivars, as well as access to fodder and other primary products (Fadda et al. 2020). Good commercial traits as well as culinary traits regarding taste, cooking and preparation time are also important (Elango and Kawarazuka 2019). Additionally cultural qualities of the cultivars are also relevant, for example, some cultivars are maintained for specific occasions, and hold specific cultural implications, and traditions (FAO 2009b). The management requirements must also fit the availability of technology, the strength and time of the crop caretakers, especially if the crops are grown distant from the home, as well as be compatible with ripening times, crop rotations, and intercropping, etc. (Gatzweiler and Braun 2016). It is generally important that risk minimization and climate change adaptation be incorporated when it comes to integrating new and existing crops or cultivars, and PGRFA that can sustain livelihoods both nutritionally and economically through selling in markets (Twine and Omore 2016). In doing so, specific trait preferences of farmers should be acknowledged and prioritized, whether that be pest resistant varieties, varieties with higher quality taste and appearance, or varieties that limit the amount of required post-harvest labor. Additionally, smallholder farmers would benefit from access to affordable, quality seed, whether that be through community outlets or larger national and international genebanks (Vernooy et al. 2020b). This could also come from farmers being able to recognize good quality seed and to work in an enabling environment after being provided seed, so that the seed has a higher chance of thriving.

The conservation and use of orphan crops, also called neglected, underutilized, or minor crops, by farmers is critical, as these crops are crucial for the food security and livelihoods of some of the most rural, poor, and marginalized communities (Talabi et al. 2022). Orphan crops are often staples for rural communities and cover the entire spectrum of food as well as industrial uses, such as cereals, fruits and nuts, vegetables and pulse crops, roots and tuber crops, oilseeds, starch and sugar, fiber, latex, and dyes (Hughes 2021). They are considered 'orphan' because of the general neglect of these crops from the scientific community, specifically the limited investment in genetic improvement and research on these crops, which is likely due in large part to the fact that they are not internationally traded at a comparable rate to crops such as wheat, rice, and maize (Naylor, et al 2004). Furthermore, orphan crops have the perception that they are 'poor farmer's crops', and therefore are met with low interest from the international farming industry due to general lack of demand (Hughes 2021). Orphan crops typically have underdeveloped seed systems, resulting in the recycling of poor-quality seeds, and therefore leading to extremely low yields (Kamenya et. al 2021). Additionally, the methodologies outlined for priority setting in agricultural development focus on areas of production and number of beneficiaries, often leaving out user groups most relying on these orphan crops, as well as neglecting their numerous potential advantages for climate change adaptation and food security (Kamenya et. al 2021). It is widely acknowledged that the use of local resources can contribute largely to climate change adaptation, as orphan crops are uniquely suited and adapted to local harsh environments, as well as provide nutritional diversity, enhance local economies, and protect local knowledge (Mabhaudhi et al 2019).

Further, CWR offer a great deal of opportunity for crop diversity and climate change adaptation, in that they are wildly grown close relatives of domesticated crops with high degrees of genetic diversity useful for crop improvement (Hunter and Heywood 2011). Wild relatives of modern crops developed with exposure and adaptation to climatic changes and adverse weather patterns, giving them high potential value in increasing relevant diverse characteristics in modern crops (Jansky et al. 2013). However, until the last decade, research was not terribly prevalent on the use, conservation, and pre-breeding strategies of CWR, and, like many wild species, CWR continue to face threats due to habitat loss, fragmentation, degradation, disturbances, and invasive plant species (Hunter and Heywood 2011). Therefore, it is important to prioritize their conservation *ex situ* so that material and data on the genetic traits of accessions is available for pre-breeding efforts (Bohra et al. 2022) and other uses. Furthermore, CWR conservation is a strong example of the strengths in applying a complementary *ex situ* and *in situ* conservation approach, as *in situ* conservation prioritizes their environment to be secured so that they may continue developing helpful adaptive traits (Castañeda-Álvarez et al. 2016). This untapped potential is largely relevant to marginal lands, lands that presently have limited capacity for food growth, which are highly vulnerable to climate change, and where many rural, poor smallholder farmers are living (Renzi et al. 2022).

When considering the overarching needs of smallholder farmers, it is necessary to address the different degrees of access to PGRFA, financial support, land, and decision-making power that members of farming communities have, specifically women and youth. (Girard et al. 2021; Puskur et al. 2021; ICARDA 2019). Depending on the community, women, for example, might need more space and resources to participate in trainings and larger decisions regarding farming, as their needs are not reflective of typically male farming roles, and therefore may be neglected when not giving them the space, ultimately hindering the overall farming process.

As we discussed in section 2.1 marginalization is highly intersectional, context specific, and complex, and all women, youth, and Indigenous people have vastly different experiences, needs, and degrees of vulnerability. However, the following section documents more clearly the generalizable roles and needs of these three groups in the context of PGRFA. Additionally, many smallholder farming communities are Indigenous to their region, and their relationship to international and national genebanks, research institutes, and policy makers is contextually dependent, as is the degree of marginalization they face (FAO 2009b). As women and youth can be Indigenous themselves, there is a great deal of overlap between the needs, roles, and degrees of marginalization.

### Women: needs and roles

The needs of women when it comes to genebanks and breeding are deeply connected to the roles that they typically play in their families and communities. Women play an important role in the conservation of genetic resources because the conservation of specific cultivars, preferred characteristics, and their improvement and adaptation to changes in environment and climate is and was traditionally entrusted to women as gatherers, cultivators, and natural resource managers (Sood et al. 2015). This is because they are largely responsible for nutrition, cooking, and health regarding their families and communities (Woroniuk and Schalkwyk 1998). Furthermore, women's relationship to orphan crops and local indigenous crops is close, as these are important for food and nutrition security and hence the crops are often utilized and conserved by women (Mabhaudhi et al. 2019).

Due to this social system engrained in many different cultures, women possess traditional knowledge passed on through generations that is crucial in crop selection and conservation, a knowledge that is arguably very different to their male counterparts (Fulton 2004). Women are responsible for a degree of precise knowledge in traits and conservation that lends them to being vital components of family and community food security. For example, a case study of Kpelle rice farms in Liberia showed that women were able to identify all present rice varieties, including description of husk, color, suitability in different soils, cooking time, and size, whereas men could not (Zweifel 1997). Additionally, in a case study on maize in China, women demonstrated specific knowledge pertaining to maize varieties that supported their conservation and dissemination (Ashby 2018).

In the context of plant breeding, women often have very different trait preferences to men and are also able to recognize traits that men may not be able to, due in large part to the roles women play in the home and community versus the roles that the men do (Sood et al. 2015). Gender-responsive breeding is a practice that seeks to consider the trait and quality preferences that differ between men and women, based on their differing roles in farming and conservation (Phiri, et al. 2022). For example, in a study of cassava traits in Nigeria, sometimes men and women had the same trait preference but for different reasons, with men preferring the Dangaria cassava because of its high yields for livestock feeding, whereas women preferred it because the young leaves were useful in preparing soups and sauces (Teeken, et al. 2018). In another study on gender-responsive breeding for sweet potatoes in Mozambique, women generally preferred sweet potato varieties that were rich in vitamins, marketable and had good quality taste. Men, on the other hand, preferred varieties that were disease and drought resistant (Mulwa et al. 2021). A further study on potatoes in Assam, India, showed a correlation between women's roles and their preferences, for example that they preferred traits which were better for cooking (smooth skin, boiling time, and texture) as well as storability for home consumption, as they are primarily tasked with cooking duties. Men, on the other hand, were more interested in disease-resistant varieties, as they are more responsible for the spraying of fungicide and pesticide and interact often with agricultural input suppliers (Elango and Kawarazuka 2019). Overall, women often preferred product quality, while men were more interested in agronomic traits. This also reflects each gender's respective roles when it comes to farming (Puskur et al. 2021). A case study in Tanzania furthered this point, where men and women respondents ranked plants differently in terms of importance, even though they had similar knowledge of the plants and their varietal traits (Ashby 2018). A compilation of case studies on gender-responsive breeding was put together by the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) and concluded that focusing the breeding methods and preferences on solely men ultimately harms them as well as women (Tufan and Grando 2018). This data informs researchers and breeders on what the PGRFA priorities are in various communities, and highlights women's crucial role in local variety conservation (Song et al. 2018).

Additionally, when, and how women feel comfortable participating in the obtaining and exchanging of seed may depend on factors that are different for men. For instance, farmers tend to trust seed provided by fellow farmers more than they trust commercial actors, but this is also gendered (Puskur et al. 2021). A study on Malawi potato farming showed that men were comfortable obtaining potato seed from outside the village, while women were more likely to access seeds from farmers they knew in their communities (Puskur et al. 2021). Considering the relationships women have with community members, seed vendors, and external parties, such as scientists and researchers, is crucial in determining and thoughtfully addressing their needs (Pineda 2019).

### Youth: needs and roles

The role of young people in agricultural communities is contingent on the hope and expectation that they will continue in and progress in the farming sector (FAO 2014). However, the question of whether young people aspire to work in agriculture is dependent on many intersectional factors, for example their access to resources and wealth (Aduroja 2021). This has put pressure on the issue of how to retain youth in agriculture and what their needs and roles in farming are.

A CGIAR cross regional perspective case study explored this topic with relation to young men and young women and found that not only is there an issue of access to land and resources for young people in general, but there is also a degree of reluctance for young women to remain in agriculture due to gendered discrimination (Elias et al. 2018). This shows again the intersectionality of marginalization. Additionally, how youth is defined remains an obstacle for accessing this group, as young mothers, for example, would not classify themselves as 'youth', which requires additional attention to language use in project development and outreach (Njuguna-Mungai 2022a).

Youth are often marginalized in agriculture because their access to land, technologies, and trainings is more limited compared to adults, specifically male adults (HLPE 2021). Additionally, access points may miss young people entirely because of misdirected efforts in outreach and engagement (Njuguna-Mungai 2022b).

The term 'youth' is often coupled with women and/or Indigenous groups because the two groups have generally limited access to land, seed, wealth, and resources, whether that be trainings, information, or technologies. For example, a project of the International Potato Center (CIP) and United States Agency for International Development (USAID) project on gender-responsive and socially inclusive approaches to potato farming in Georgia highlights women, youth, and two ethnic groups (Armenian and Greek) as key focal points for inclusion (Girard et al. 2021). Despite being grouped often with women in outreach programming

(Girard et al. 2021), the needs of youth differ greatly from women, in that the motivation behind including youth is to incentivize them to remain in farming, as many young people find agriculture to be a difficult career path with their limited access to land and resources, as well as an uninteresting and unmotivating one (Kinyua 2018).

Therefore, their needs are predicated on what is needed for them to remain in agriculture, for example better access to information, better resources of knowledge sharing, and stronger education in agriculture (FAO 2014). Additionally, to put into practice the progressive technological and innovative developments in farming, young people need access to land, which is often extremely difficult due to restrictive inheritance laws (especially for young women), as well as financial services, which are also often barred from young people due to their financial illiteracy and lack of collateral (FAO 2014).

There are initiatives taking place that are focused on empowering youth in terms of recent graduates being trained in agricultural business. The International Institute for Tropical Agriculture's (IITA) *Youth Agripreneurs* project focuses on youth unemployment in Africa. In the context of this project, youth is 'marginalized from the economic mainstream', and young people are trained in an incubator system for 18 months where they learn about the business of commodities such as cassava, maize, soybean, plantains, bananas, fishery, and piggery (IITA 2022). The Africa Rice Center (AfricaRice) also has a strong focus on youth employment through the project *Promoting youth entrepreneurship and job creation in West Africa's rice value chain*. This initiative provides training in entrepreneurship and integrated crop management and cooperates with various agricultural centers to foster youth involvement (AfricaRice 2022). While youth engagement is often mentioned and its importance acknowledged, there were few standalone projects that highlighted these efforts.

### Indigenous groups: needs and roles

The role of Indigenous persons in agriculture is strongly tied to tradition and history, with Indigenous knowledge at the core. This is widely appreciated in scientific literature as a key element of food security (Mafongoya and Ajayi 2017); however the use of this knowledge is often not met with consideration for the rights and needs of Indigenous groups as well as the full acceptance of their contribution to biodiversity (Mollins 2019). There are layers to agricultural knowledge in farming and conservation that are maintained and protected by Indigenous communities. Indigenous communities around the globe have, for millennia, used their evolved traditional knowledge, passed down through generations through written, oral, and non-verbal means, to ensure food and livelihood security in a wide range of changing ecosystems (FAO 2009b).

In order to protect food security and build upon this traditional knowledge, Indigenous smallholder farming communities need land rights, the protection of local cultivars, the return of indigenous cultivars through repatriation of landraces, and resources, support, and time to develop and grow new varieties in new environments, as many Indigenous communities continue to be pushed out of their ancestral homes and displaced (Mafongoya and Ajayi 2017). Additionally, Indigenous farmers who have conserved and developed crops over generations to withstand changing environmental and agricultural conditions as well as locally specific diseases and pests should be considered plant breeders. In this way, they should have access to data sharing and rights protections, as prescribed in the Nagoya Protocol. As these are the qualities of breeding, especially in orphan crops in the face of climate change and the restructuring of food security frameworks, that plant scientists are also focused on (McCune 2018). The Nagoya Protocol provides for fair and equitable sharing of benefits that arise from biological diversity and recognizes the contributions Indigenous plant breeders make to biodiversity research and conservation. In the face of the *Indigenous Data Sovereignty* movement, and the discussion to include data sequencing in benefit sharing, there is potential to create a collaborative, innovative, and mutually beneficial relationship between the formal seed system and communities and could increase Indigenous persons' motivation to participate and share resources (Ambler et al. 2020).

## 3.2. Options for inclusivity of *ex situ* conservation institutions

Before different options of inclusivity for marginalized groups are described, it is important to explain what inclusiveness means in this study. Inclusivity as a term has multiple definitions. Cambridge dictionary defines it as 'the quality of trying to include many different types of people and treat them fairly and equally' (Cambridge 2022), and the Oxford dictionary defines inclusivity as 'the practice or policy of providing equal access to opportunities and resources for people who might otherwise be excluded or marginalized' (Oxford 2022). Combining these two definitions provides us with ultimately two routes of inclusivity for institutions of *ex situ* conservation that can also be applied together, with regard to including marginalized groups: Inclusivity can be realized through storing resources which could be useful now or in the future, as well as through the pursuit of different genebank activities and strategies to distribute the material to marginalized groups or other stakeholder such as breeders who act as intermediaries between *ex situ* conservation and marginalized groups. In the following, possible opportunities for engaging with marginalized groups are described.

**Institutions of *ex situ* conservation as repositories of plant genetic resources and accession-level data**

Institutions of *ex situ* conservation are repositories of PGRFA, as they store landraces, modern varieties, CWR and sometimes primitive or obsolete cultivars (Engels and Ebert et al. 2021). Now and in the future, this diversity of material can be useful for many different stakeholders who use PGRFA such as farmers and breeders or pre-breeders; and ultimately for all consumers of PGRFA, hence humanity. This safeguarding is the core activity of genebanks, which could also be termed 'plant genetic resources conservation centres' (Engels and Ebert 2021). Effective conservation is critical in determining the usefulness of genebanks for marginalized groups. Orphan crops are most utilized by rural, poor, and Indigenous communities, and therefore the improvement, protection, and conservation of orphan crops is highly beneficial to their user groups (Talabi et al 2022). Millets, for example, contain high nutritional value, and grow in adverse conditions, such as poor soils, minimal rainfall, and high temperatures, while also contributing to food security (Hughes 2021). In conserving crops such as this, genebanks are protecting and improving the genetic materials most utilized by rural, marginalized communities. However, while genebanks conserve select orphan crops (Tadele 2019), and many genera, there are many orphan crops that are not being conserved (Galluzzi et al. 2016).

Genebanks can provide many valuable accessions to improve farmers' food and seed security now and in the future. As smallholder farmers and most other PGRFA-users do not have the means to physically store all germplasm which might be useful to them (Bhutani 2019), genebanks have the important responsibility to safeguard PGRFA for humanity and make them accessible. This limited capacity to store material is particularly evident for marginalized groups as they might have restricted access to knowledge on PGRFA and storage options as well as limited space to store material under suitable conditions (Sood et al. 2015).

It is hereby important to note that the quantity as well as the quality of accessions stored *ex situ* is crucial for their usefulness for users such as marginalized farmers. When material stored *ex situ* is transferred to farmers' fields, it should be disease-free so that diseases cannot decrease agricultural production or spread further. This phytosanitary quality is vital to maintain genebank collections and hence marginalized groups can take advantage of the material quality if it is distributed to them. The distribution of disease-free material was, for example, important for the creation and success of the potato repatriation by CIP, as farmers' accessions had deteriorated over time (Lüttringhaus et al. 2021).

Apart from storing plant genetic resources, genebanks are institutions where information on the conserved accessions is generated, stored and often made available to users. An example of such data is accession-level passport data. It is basic information about the origin of an accession such as details recorded at the collecting site, as well as further trait observations (e.g., tuber shape), suitable climate etc. Further characterization and evaluation data adds value to the accessions (Galluzzi et al. 2016) as the quality and relevance of the accession-level information made available by institutions of *ex situ* conservation is one of the most important factors in determining demand for certain accessions (Halewood et al. 2020).

Institutions of *ex situ* conservation can select and prioritize the PGRFA they conserve. This choice can strengthen the inclusion of marginalized groups and the usefulness of *ex situ* conservation for them, if their needs and priorities are known, by conserving and making accessible relevant PGRFA. For example, PGRFA with specific nutritious or agronomic traits such as resistances and tolerances can be very helpful for marginalized groups if they grow in their areas and meet their culinary, cultural, agricultural, and economic conditions. To gain a better understanding of the value of PGRFA to marginalized groups, it is helpful to understand the sources that create their value (Smale and Jamora, 2020). Depending on their traits, usage, and availability, PGRFA have different economic, agronomic, and cultural values and benefits (Lüttringhaus 2022). Taking the perspective of resource economics, one option to conceptualize the sources of value is through the framework of total economic value (Smale and Jamora, 2020). According to this framework, the total value of a resource is composed of use and non-use values (see Figure 1). The latter consists of an existence and inheritance value. This means that the mere existence (in a genebank or on fields) or possession (realized through purchases, inheritance etc.) of a PGRFA can be valuable for a marginalized farmer, irrespective of its use value. Use values can be direct and indirect and consider current and future usages such as being a staple food or fodder. In addition, there is an option or insurance value, which considers certain PGRFA to be potentially useful for future uses, such as adaptation to climate change. This form of use is particularly crucial for the livelihoods and food security of marginalized groups which often farm with low inputs on marginalized lands. Hence the quality (e.g., drought tolerance) of used PGRFA is crucial and therefore this future value creation offers great potential for institutions of *ex situ* conservation to be inclusive. In the following section this important aspect of genebanks holding valuable resources for the future will be explained further by describing their contribution to climate change adaptation.

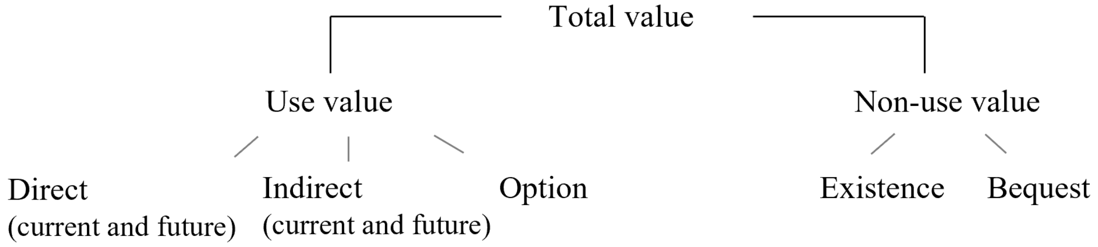


*Figure 1: Total economic value framework as presented in Smale and Jamora (2020).*

### Institutions of *ex situ* conservation as distributors

The conservation of PGRFA in repositories is a precondition for being able to make PGRFA available to external users, including marginalized groups. To be useful for marginalized groups, it is necessary that institutions of *ex situ* conservation have good-quality material and accompanying data available for distribution. Further the available PGRFA should match the needs and priorities of marginalized groups to be useful to them. Genebanks can distribute these resources directly by themselves or indirectly through intermediaries such as national research services to farmers' seed systems. However, the practical usefulness of the accessions also depends on their availability and reproduction type (e.g., *in vitro*, seeds) and often genebanks cannot provide farmers with sufficient material, meaning that farming communities, for example, must do the multiplication (Lüttringhaus et al. 2021), and this is a tremendous effort for which the resources are often not provided.

Working directly with marginalized groups can be realized through a variety of means, for example participatory plant breeding (PPB), field days, and organized training or programs. This option of direct interaction ensures that institutions have control over what is being done with the resources they safeguarded as they can design and implement the activities and strategies by themselves. If an institution of *ex situ* conservation holds useful resources, but distribution is done through intermediaries, it is difficult to control exactly how the material is being used. Determining which stakeholder is best equipped to include marginalized groups through distributing PGRFA highly depends on the locality, timing, and context of an activity. Nevertheless, no direct reciprocal learning or exchange between marginalized groups and institutions of *ex situ* conservation can take place when there are intermediaries between them. The quality of inclusion through intermediaries hence depends on the quality of the original PGRFA and data provided, and the success of activities and strategies implemented by the intermediaries. Depending on the circumstances, intermediaries might be better equipped than genebanks to cater to the needs of marginalized groups with respect to PGRFA.

The question is then which services genebanks or intermediaries can offer to transfer material stored *ex situ* to marginalized groups: repatriation, rematriation, seed distribution upon request, identification of plants, consultations regarding best cultivar choices (agronomic, nutritional, economic, and other properties), extension services etc. Further, genebanks can create, store, and publish data on accessions' traits and other information which can be useful for marginalized groups and stakeholders connecting genebanks with marginalized groups (e.g., breeders). In the following, different options to introduce PGRFA stored *ex situ* will be described, as these describe possible actions or strategies on how genebanks can directly distribute material to farmers and hence make their material available to external users.

The direct transfer of material from *ex situ* conservation to farmers' seed system can be realized through various activities or institutions, which can be categorized in six approaches highlighted in yellow in Figure 2: Reintroduction, emergency seed intervention, variety introduction, PPB, community seedbanks and integrative seed system approaches (Westengen et al. 2018). Further, farmers and genebanks can connect through the collection of material, where material flows from farmers' fields to genebanks. All approaches are highly interlinked and some direct distribution activities may belong to several approaches. Further, other PGRFA stakeholders apart from institutions of *ex situ* conservation (e.g., national research institutes or extension services) could pursue these activities individually or together with genebanks.

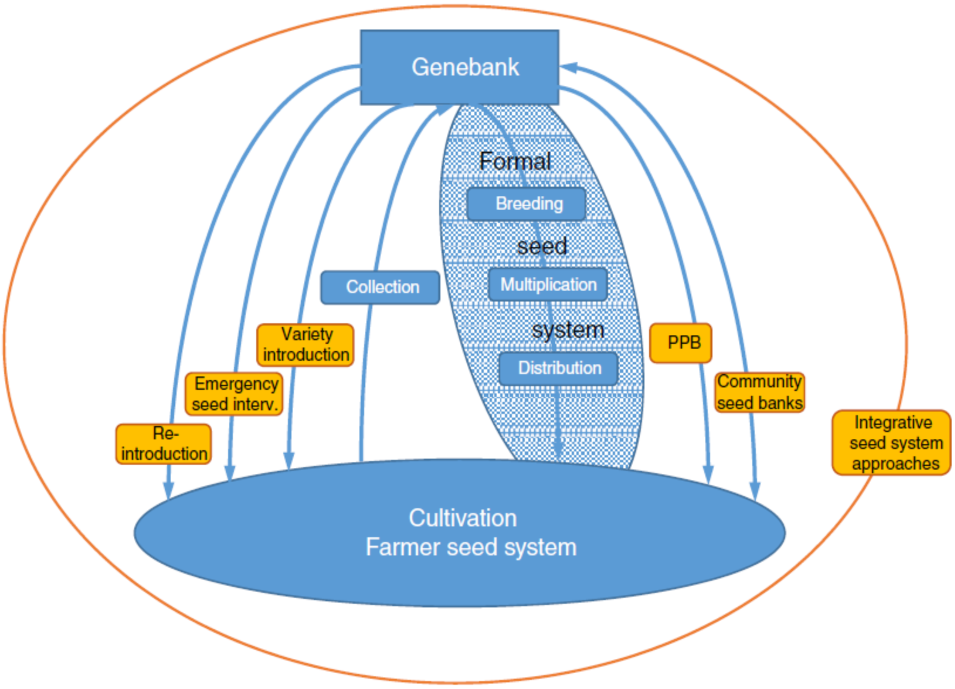


*Figure 2: Approaches to introduce ex situ conserved genetic material in farmers' seed systems, and vice versa, source: Westengen et al. (2018).*

### Reintroduction

Reintroduction is the direct transfer of material from *ex situ* collections to farmers as individuals or groups. This is done to restore lost, diminished, or unhealthy crop cultivars that were originally obtained from the same geographical area or similar agroecological environment (Westengen et al. 2018). This process can be also called repatriation or rematriation (Ocampo-Giraldo et al. 2020; Lüttringhaus et al. 2021). For reintroduction to take place, farmers' rights to access and use such material must be recognized (Sperling et al. 2013). The success of reintroductions depends on the genebank's and farmers' or community's capacities to provide and multiply sufficient and healthy material (Lüttringhaus et al. 2021). Furthermore, CGIAR genebank heads generally presented the concern with reintroduction that material that has been collected decades ago might not thrive anymore in its place of origin as environmental conditions may have changed. This issue can be overcome by testing the material on site and providing the marginalized farmers with well-selected material that fits farmers growing conditions and meets other needs.

### Emergency seed intervention

Emergency seed intervention is the distribution of seed to farmers in emergency and post emergency recovery situations and is a critical element of humanitarian relief efforts (Westengen et al. 2018). This is also the most common agricultural aid intervention, with seed being distributed by NGOs and governments. While the benefits of reaching smallholder farmers are strong, there are several challenges and criticisms to the effectiveness of the intervention (Sperling and McGuire 2010). For example, governance over seed aid is often minimal, as well as clearly sought objectives and records of distribution being poorly transcribed or not determined, and the methods for distribution have often overlooked context specific factors, such as the seed systems in place and the disaster's impact on them (Sperling and McGuire 2010). However, more recently, and especially with the COVID-19 Pandemic, the focus is shifting toward more tailored interventions that strengthen the resilience of seed systems, with the intention of aiding in long-term support (Global Food Security Cluster 2020).

### Variety introduction

Variety introduction refers to the introduction of varieties that are improved by breeders. These varieties are bred to survive and thrive in specific climates, and which also have specific new traits such as increased yield levels or resistances (Westengen and Winge 2020). This type of introduction relies on a direct link between genebanks, breeders, and farmers utilizing new varieties. The process of variety introduction usually requires an extensive amount of crop genetic diversity to find suitable cultivars or traits within a large genetic pool (Fadda et al. 2020). A project example of this being done by ABC is Seeds for Needs, which provides climate adaptive seeds to smallholder farmers and promotes the development of citizen scientists in breeding initiatives (van de Gevel et al. 2013).

### Participatory plant breeding

Participatory plant breeding (PPB) is the process by which testing, and selection take place on farm as opposed to on-station, and therefore allows key decisions to be made by both the farmer and the breeder. PPB also enables the testing of material in marginalized and low input agricultural systems which are often not the target group of conventional breeding programs (Ceccarelli and Grando 2007). Farmers are active participants in the initial phases of PPB, by multiplying seed and utilizing the seed systems within their communities and villages. It is a process that is both flexible and adaptable and allows for new varieties to reach the release phase quickly, while also proactively addressing farmers' needs (Ceccarelli and Grando 2020).
PPB not only directly involves farmers' knowledge and needs, but it is also an active way to implement Farmers' Rights and sustainable use under the ITPGRFA (Winge 2020). Despite this, PPB, as a practice, struggles to gain favor, even with organizations working to reduce poverty and malnutrition and support smallholder farmers by improving their livelihoods. This is due mainly to the slow adoption of a paradigm shift, in which farmers are at the forefront of, and actively engaged participants in, breeding initiatives (Ceccarelli and Grando 2020). In contrast to the plant breeding programs of the Green Revolution, in which the objective was state intervention in agricultural development and the initial germplasm was developed by International Agricultural Research Centers, PPB is an element of the 'farmers first movement' (Chambers and Ghildyal 1985) that continues to change the agricultural development agenda (Westengen et al. 2018). The scientific basis of PPB comes from selection theory and variety adoption dynamics. This, combined with the high probability of adoption of varieties created through PPB, plus higher biodiversity with the new varieties, depending on the context, can be produce higher cost-benefit ratio than with non-PPB methods (Ceccarelli and Grando 2020), and also higher yields overall in agricultural areas which are not high-potential (Westengen and Winge 2020). For example, a PPB program in Syria found that while the program's rollout and initiation was an investment, the projected economic benefits for the following season more than tripled the whole investment into the program. Farmer's participation in the program also had a positive impact on both their economic status and livelihood (Mustafa et al. 2006).

The decentralized selection of the breeding material and varieties also supports a breeding environment that is conducive and adapted to marginalized land, as opposed to focusing on high input, favorable farming environments (Ceccarelli and Grando 2020). Furthermore, PPB can support farmers' empowerment by strengthening their organizations and capacities, as well as women's empowerment by including their needs and concerns about food processing and nutrition. Agrobiodiversity also benefits from PPB, as local germplasm can be used for developing varieties, thus enhancing varietal diversity cultivated by farmers (Weltzien et al. 2020), and ultimately strengthening adaptation to climate change (Westengen and Winge 2020). Additionally, in the pre-breeding of CWR, there is potential for close collaboration in PPB with local and indigenous communities (Satori et al. 2021).

### Community seedbanks

Community seedbanks are institutions organized by farmers to facilitate the development, preserving, and sharing of seed (Westengen et al. 2018). This practice, as old as agriculture itself, involves farmers directly as managers of seed in selection, conservation, multiplication, and improvement, and this practice of formal and informal seed sharing between farmers is the most common form of seed access for smallholder farmers globally (Song et al. 2021). Community seedbanks are often funded by NGOs or in direct collaboration with national genebanks, agricultural research institutions, or universities, depending on the region (Global Alliance 2016). Typically, community seedbanks conserve landraces as this is what is most readily available and used; however improved varieties can also be incorporated depending on the availability. This is also an example of how formal and informal seed systems can be integrated (Vernooy et al. 2022).

### Integrative seed system approaches

Integrated seed systems generally comprise collaborative and coordinated actions between the formal and informal seed systems (Sperling et al. 2013). This is reliant on the additional integration of conservation of agrobiodiversity with the empowerment of local communities, specifically through sustainable use and equitable and fair benefit sharing (Westengen et al. 2018). While the formal seed system is one that is deliberately designed to be bound and structured with clear deliverables, such as certified and verified seed varieties, the informal system is where most smallholder farmers source their seed, by planting, exchanging, and selling a range of varieties that exist outside the production functions of the formal sector (Sperling et al. 2013). The concept of pluralism within integrative seed system approaches examines ways to make seed interventions congruent with the systems utilized by smallholder farmers, and that both the informal and formal seed channels should be focused on farmers accessing suitable seed (Westengen et al. 2018). Examining ways to coordinate between these two systems allows for the approach of farm management to shift from purely conservation focused on long-term socio-economic development of sustainable livelihoods, within the framework of smallholder farmer seed systems and with consideration to smallholder farmers' preferences (De Boef et al. 2010).

### Collection

Another direct exchange between institutions of *ex situ* conservation and farmers is the introduction of material obtained through collection missions by researchers (see Figure 2) (Westengen et al. 2018). This means that the material flows the other direction, from farmers' fields to genebanks or other institutions of *ex situ* conservation such as community seed banks. Such missions also offer the opportunity for genebanks to connect with farmers, learn more about the environment the PGRFA material grows in as well as important agronomic and nutritional traits. Hence, such collections could be an ideal opportunity for retrieving data on accessions which is useful for marginalized groups, as well as starting good relationships with the custodians to strengthen inclusiveness and mutual understanding.

### Indirect distribution to marginalized groups

As most of the genebank material is not directly distributed by genebanks to marginalized groups or farmers, there are multiple ways in which genebanks can indirectly connect with marginalized groups and distribute the stored material through intermediaries to them. The options also work for indirect distribution. Another such indirect link is through the breeding, delivery, and adoption flow (see blue stream in Figure 2). This process, where breeders and multipliers are the intermediaries between genebanks and farmers, is termed ‘breeding, delivery and adoption’ (Challinor et al. 2016). For maize, for example, this process can take up to 30 years (Challinor et al. 2016). This implies a long lag between selecting possible breeding material as well as the traits of future varieties and the actual planting of these varieties. Genebanks can facilitate this process by providing information on material’s origin, characterization, agronomic and nutritional traits, farmer evaluations and other available information to all stakeholders (breeders, farmers, multipliers, processors etc.) which can help them to select material.

**Climate change adaptation and *ex situ* conservation**

The variability of the production systems for food security has, for generations, been managed by farmers, forest dwellers, pastoralists, and fisherfolk, in an agroecological system, however climate change now influences more the extent and distribution of genetic diversity in food security (FAO 2015) and accelerates impacts felt by farmers. Farmers need new crops and crop varieties that can be grown in changed farming environments, as climate change affects temperature, precipitation, seasons, soil, and the length of crop growing periods, making it so crops that once thrived are unable to survive in the new climate conditions (Snook et al. 2011).

The continued existence of species, varieties, and breeds is threatened, and requires the increased conservation and use of genetic diversity. Genebank collections were established to conserve diversity, and despite their vastness on an international and national scale, today’s collection does not represent the full range of crop gene pools of interest for adapting to climate change. Additionally, the cataloged information on genetic traits is not entirely comprehensive, and most samples lack characterization and evaluation data (Ford-Lloyd 2003). For genebanks to fulfill their role completely in climate change adaptation efforts, trait information needs to be available to researchers, breeders, and farmers. This idea is well recognized by the international agricultural community, and hence an integrated information portal was created which exists online and is called GENESYS. Today it holds more than 750,000 accessions (Snook et al. 2011). The topic of characterizing accessions continues to be at the forefront of genebank programming on a smaller scale as well. For example, CGIAR genebanks are participating in the *Mining Useful Alleles for Climate Change Adaptation* project, led by the International Maize and Wheat Improvement Center (CIMMYT), which identifies plant accessions that contain gene variations corresponding to characteristics such as heat, drought, or salt tolerance, and to facilitate their use in crop breeding (Hearne 2021). This is done using high-performance computing, GIS matting, and new plant breeding methods.

Genebanks already store multitudes of adaptation options; the challenge is how to identify and then disseminate the germplasm and seeds in a way that meets the needs of farmers and promote resilience in the production system. The conservation and use of CWR also holds great potential in breeding climate adaptive traits, as wild relatives contain a wealth of genetic diversity that is often not present in modern crops (Tyack and Dempewolf 2015). Conserving these CWR in genebanks and identifying which traits have high potential or success in adaptation to climate change is a critical aspect of pre-breeding and has gained more traction in the international community in recent years as an avenue to harness diversity and protect food security (Dempewolf et al. 2014). Another project utilizing genebanks as sources of genetic material in climate adaptation is the *Seeds for Needs* project spearheaded by the Alliance of Bioversity International (Bioversity) and the International Center for Tropical Agriculture (CIAT) (ABC). In collaboration with Ethiopia’s national genebank, the Ethiopian Biodiversity Institute, an atlas was created that categorized accessions based on suitability for present and future climate conditions, and an agreement was formed with community genebank managers to assure the accessions would be available for farmers' use (van de Gevel et al. 2013).

As tropical and subtropical regions are projected to experience the most severe climate changes, capacity building in these regions, to both utilize materials in breeding new crop varieties and support and understand community seed systems so that germplasm can be distributed to farmers, can be efficient and adaptive (Franks and Hoffmann 2012; IPCC 2022).

## 3.3. The state of inclusiveness of institutions of *ex situ* conservation

The following sub-chapter describes how and to what degree the varying needs of marginalized groups in the smallholder sector are currently being addressed by *ex situ* conservation activities and priorities. This sub-chapter further analyses how and to what degree the varying needs of marginalized groups in the smallholder farming sector are currently being addressed in *in situ* conservation methods carried out or supported by institutions of *ex situ* conservation. Table 3 in the Annex summarizes genebanks, programs, projects and organizations which include aspects of marginalization or marginalized groups in their work, and also highlights if they make a connection between *in situ* and *ex situ* conservation.

When exploring the understanding of interviewees of marginalized groups with respect to the conservation of PGRFA and the work done with them, one opinion stood out: Most interviewees saw rural smallholder farmers generally as marginalized. As there remains much to do to improve their food security and livelihoods, smallholder farmers were understood as a large focus group for PGRFA activities. Beyond the general focus on smallholder farmers, most interviewees put special emphasis on the integration of women, as they often have specific roles within households and differ in their access to resources. Therefore, interviewees generally found that working directly with smallholder farmers is seen as an example for working with marginalized groups. This means that also inclusive actions, strategies, or resources of genebanks are showcased here even if they do not explicitly target marginalized groups, but rural smallholder farmers in general, as their marginalized location and subsequent poverty have characterized them as marginalized. Consequently, within the realm of this study marginalized groups are seen as a specific subgroup of smallholder farmers (see section 2.1).
According to most interviewed experts, no risks were seen in integrating marginalized groups in *ex situ* conservation work and priorities. On the contrary, their integration was rather seen as a necessity to improve their food security and livelihoods, recognize their different contributions to the conservation of PGRFA, and achieve the objectives of a respective genebank, program, project, and organization. The largest impediments that hamper the inclusion of marginalized groups mentioned by interviewed experts and genebanks heads were a lack of funding, and consequently time, resources, and staff.

As elaborated in sub-chapter 3.2, in addition to PGRFA accessions, genebanks hold valuable information on these accessions. This information is crucial for investigating and using specific accessions. Furthermore, it can be beneficial for integrating the needs and priorities of marginalized groups in *ex situ* conservation e.g., through providing them with suitable material based on information such as agronomic or nutritional traits. To this end, genebanks can store information in their own genebank information system or use wider connected information systems which might connect several *ex situ* collections. Although all interviewees were asked what kind of genebank information systems they used or which data could be helpful for strengthening the role of marginalized groups, interviewees did not refer to individual or broader information systems. They rather mentioned the use of particular accession-level data, such as agronomic, nutritional and other traits, to find suitable accessions for marginalized groups or lands.

From our research, international genebanks seem to utilize their own individual information systems, as well as international information databases. Genebank information systems have the potential to not only grow but globally connect relevant accession-level data (Weise et al. 2020). As of now, there are many genebank information systems being utilized by many countries and their genebanks. One such system, for example, is FAO's World Information and Early Warning System on PGRFA (WIES) which prepares and provides country-specific global assessments assessing conservation and use of PGRFA. WIES has more than 17,000 national, regional, and international partner institutes and organizations, where they may exchange information about germplasm (Weise et al. 2020). Additionally, the European Search Catalogue for Plant Genetic Resources (EURISCO) contains information on more than 2 million accessions of crops and their wild relatives, and passport and phenotypic data, preserved by 43 member countries and roughly 400 different institutions, however data accessions cannot be ordered directly, and they are not guaranteed to be available (EURISCO 2022). Currently GENESYS holds the most accession records, with over 4 million including passport and phenotypic data. EURISCO and the US GRIN (the US germplasm resource laboratory) regularly feed data into GENESYS as well. It contains information from three of the largest genebank networks, the European Cooperative Program for PGR (ECPGR), CGIAR, and the US Department of Agriculture (Mekonnen and Spielman 2021).

These genebank information systems make significant contributions to sustaining and documenting PGRFA and make it easier to access information, as well as coordinate the conservation of collections. Article 17 of the ITPGRFA outlines a vision for a global information system (FAO 2009a), and since 2015, a Global Information System (GLIS) based on existing information systems is in development by FAO (Weise et al. 2020). These genebank information systems, however, are currently limited mainly to passport and phenotypic data, but promising collaborative results could come from including more genotypic and agronomic characterization (Weise et al. 2020). Furthermore, trends in conservation of PGRFA have been influenced globally by the Nagoya protocol, the ITPGRFA and the Convention on Biodiversity, highlighting that the restrictions imposed by the good intended legal frameworks may often hinder collaborations and the sharing of accessions (Mekonnen and Spielman 2021).

All of this to say that a global system requires more data and better global access to it. The literature, however, did not expand on how these various genebank information systems are considering the specific needs of marginalized groups. Therefore, it can be concluded that the needs and priorities of marginalized groups are yet to be included in genebank information systems.

### International genebanks

To assess how and to what degree the varying needs of marginalized groups in the smallholder farming sector are currently being addressed by international genebanks, it is important to look at their distributions to external organizations. As the CGIAR genebanks are currently the largest and most frequently accessed network of global *ex situ* collections (Smale and Jamora 2020), this section will mainly discuss statistics and initiatives from the

CGIAR genebanks. These hold more than 700,000 seed accessions which are held in trust as global public goods (Hay et al. 2021). Between 2017 and 2021 the CGIAR genebanks distributed most material to the user group Agricultural Research Institutes (ARIs) or universities (44 %), followed by distributions to National Agriculture Research Systems (NARS) or national genebanks (35 %) (Table 1). To a lesser extent, CGIAR also distributed material to *the commercial sector* (9 %). Finally, the user group *farmers, farmer organizations and NGOs* received on average 8 % of all external distributions. This user group comprises individuals and organizations and is of interest for this study, as marginalized groups are a sub-group of them. Individuals and unknown users received 4 %. This shows that on average CGIAR genebanks distribute few materials directly to farmers, but also that they cater to very diverse user groups (Westengen et al. 2018).

*Table 1: Percentage of external CGIAR genebank distributions by user group, source: CGIAR (2022a).*

| Year | Percentage of external CGIAR genebank distribution (%) | | | | |
|---|---|---|---|---|---|
| | ARIs or universities | NARS or national genebanks | Commercial sector | Farmers/ farmer organization/ NGOs | Individuals/ unknown/ other users |
| **2017** | 32 | 50 | 4 | 6 | 8 |
| **2018** | 56 | 31 | 5 | 6 | 2 |
| **2019** | 38 | 31 | 13 | 15 | 2 |
| **2020** | 42 | 31 | 15 | 10 | 2 |
| **2021** | 51 | 34 | 7 | 4 | 4 |
| **AVERAGE** | 44 | 35 | 9 | 8 | 4 |

As there are large differences between the centers, it is interesting to further investigate external distributions to famers by individual centers (Table 2). Looking at the average between 2017 and 2021, the World Agroforestry Centre (ICRAF) distributed most directly to farmers (77.1 %). The second largest share of external distributions to farmers is pursued by CIP (56.2 %). The remaining centers distributed a small percentage directly to farmers.

*Table 2: Percentage (%) of external distributions by CGIAR genebanks to the user group farmers/farmer organizations/NGOs, source: Halewood et al. (2020)*

| Center | 2017 | 2018 | 2019 | 2020 | 2021 | Average per center |
|---|---|---|---|---|---|---|
| **AfricaRice** | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.1 |
| **Bioversity** | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 0.7 |
| **CIAT** | 1.3 | 6.0 | 4.2 | 9.1 | 13.7 | 6.9 |
| **CIMMYT** | 2.3 | 0.2 | 0.6 | 0.0 | 2.1 | 1.0 |
| **CIP** | 9.8 | 54.1 | 87.3 | 81.1 | 48.6 | 56.2 |
| **ICARDA** | 0.0 | 0.0 | 21.1 | 7.0 | 3.1 | 6.2 |
| **ICRAF** | 87.0 | 85.7 | 96.2 | 85.9 | 30.6 | 77.1 |
| **ICRISAT** | 0.1 | 0.0 | 0.0 | 4.3 | 0.0 | 0.9 |
| **IITA** | 0.1 | 0.0 | 0.3 | 0.7 | 0.4 | 0.3 |
| **ILRI** | 0.9 | 1.6 | 1.2 | 1.1 | 7.5 | 2.5 |
| **IRRI** | 1.9 | 1.1 | 0.7 | 0.3 | 0.9 | 1.0 |

Even though most genebank heads name farmers as their target group during our interviews, most genebanks distributed very little directly to farmers, and hence also to marginalized groups. Most genebanks are involved in projects which target and include marginalized groups, but they are rather at the beginning or upstream of the process, providing material which is then used by other stakeholders, such as the centers' breeding programs. Many genebank heads said during the interviews that they also receive few requests by farmers, therefore direct use is very limited. This finding from the interviews can be seen in the data presented above. However, the degree to which genebanks provided direct support through seed transfer and repatriation, capacity building, training, or the degree to which they participate in projects by led by other departments designed to reach marginalized groups, varies from international genebank to genebank. This is seemingly due to varied national environments in which the genebanks operate, different interpretations of the mandate, the degree of responsibility genebanks must engage directly with farmers as well as the available resources (e.g., time and staff). Further personal relationships by genebank staff to marginalized groups is crucial in starting and maintaining activities of reintroduction and other forms of direct interactions with farmers (Lüttringhaus et al. 2021). The potential of direct interaction also varies according to crops conserved by each genebank. Moreover, other available resources which farmers could access locally from NGOs, national genebanks, and other agricultural extension services determines the scope of international genebanks in working directly with farmers. The local institutional environment also determines which stakeholder is best fit to transfer PGRFA stored *ex situ* (and the data attached to it) to marginalized groups.

The relationship between genebanks and farmers has, historically, emphasized conservation as the utmost objective, however Westengen (2017) highlights a current shift towards use of diversity for enhanced agricultural outcomes, indicating a cultural shift toward integrating and supporting farmer-led seed systems, as well as toward an understanding of farmers as users and beneficiaries of crop diversity (Westengen et al. 2017). However, this approach was not taken by the majority of genebank heads, who considered their ultimate role as being first and foremost one of conservation.

International genebanks are not typically directly involved in farmer-related projects, according to many of the genebank heads. To determine the degree to which CGIAR genebanks and centers include marginalized groups and how they define marginalization in different project contexts, thorough desk research was carried out. Table 3 in the annex summarizes all of the projects on which published information was found online and which have a specific focus to include some marginalized group. Drawing on information of projects including marginalized groups from the CGIAR centers' websites, it is unclear the degree to which genebanks are active project participants, or static distributors of seed. Furthermore, the degree that a CGIAR genebank is involved in farmer centered programming is dependent on the center, as there is no clear standardization across the system regarding genebank involvement. For example, the CIP genebank head acknowledged during the interview the strong involvement of the CIP genebank in the Latin American, and more specifically the Peruvian community, with the repatriation of potato landraces, and that it was unique to have the genebank so close to farmers. On the other hand, the AfricaRice genebank head expressed interest in more programming working directly with farmers, but the funding is not available and the work with farmers is designated to breeders instead. The amount of direct contact CGIAR genebanks can have with farmers also seems to be dependent on how many intermediaries there are, as well as the national legislation stipulating seed repository mandates, seed distribution, extension services and the chain of command in such processes.

Other genebanks that seem to have direct contact with farmers are IITA through their emergency seed intervention program *Seeds of Hope* (Atser 2012), and CIMMYT and CIP in their repatriation or rematriation programs with local farming communities. Looking at these two examples it is important to note that the CIMMYT and CIP genebanks of both centers are very close to the center of origin of some crops they conserve (e.g., potato and maize) and hence are closer located to the communities that used and conserved them *in situ* for generations. Further, ICRAF is distributing most of the material directly to farmers (see Table 2). Breeding activities, thus far, seem to be the most streamlined way that international genebanks can work indirectly with marginalized groups, specifically smallholder farmers, women, and Indigenous communities, who can adopt the new varieties created with material stored *ex situ* (Ceccarreli and Grando 2020; Tufan and Grando 2018). Regarding the centers themselves, all CGIAR centers had programs involving either PPB, capacity building in gender inclusionary practices and technologies, or gender-responsive breeding. Some centers focused more on youth inclusionary programs than others, depending on the region. In Africa, for example, IITA strongly includes youth programming through the *Youth Agripreneuers* program. Other centers focused on initiatives like community seedbanks. ABC, for example, developed the first handbook on establishing community seedbanks. (Vernooy et al. 2020a).

Another example of potential international genebank cooperation with farmers is the *Seeds for Needs* program originated at Bioversity, now ABC, as well. It is a climate change adaptation and resilience program that diversifies crop varieties in poor smallholder farming communities and encourages farmers to become citizen scientists (van de Gevel et al. 2013). This program now exists in 14 countries across Africa, Asia, and Central America. While the center’s programming heavily involves farmer participation, the head of the genebank was not involved directly in farmers interactions in any significant capacity and maintained the sentiment that international genebanks are vehicles for conservation and development, and not involved in *in situ* farmer initiatives. Because of their regional knowledge and designated resources for working with farmers, national genebanks and research centers are often more equipped to push *in situ* projects forward. This project, however, highlights the potential for successful collaboration with farmers and genebanks, and is ongoing and successful.

Additionally, the World Vegetable Center (WorldVeg) implements a seed sharing project between 2013 and 2017, in which over 42,000 seed kits and over 183,000 seeds were distributed to smallholder farmers in Kenya, Tanzania, and Uganda (Stoilova and van Zonneveld, 2019). The accessions were tested under local conditions for yield, resistance, and preference, and then were distributed through farmer groups, local governments, and international NGOs, as well as WorldVeg projects. These were not emergency seed aids, but rather aimed at improving diversity and nutrition (van Zonnevelt et al. 2021). The project served as another example of a successful partnership between genebanks and public, private, and societal actors with the goal of providing smallholder farmers with increased genetic diversity.

The conservation of and research on regional orphan crops is also a way that international genebanks can adhere to the needs of marginalized groups, by specifically conserving crops that are most utilized by them. For example, ICRISAT has in recent years focused on the development of several varieties of orphan millets to be pest and disease resistant, adaptive to abiotic stresses such as drought, poor soils, and high temperatures, and with higher yield and nutritional value (Hughes 2021). Additionally, in 2011, the *African Orphan Crops Consortium* was established with the goal of reducing malnutrition by improving locally adapted nutritious, under-researched, neglected orphan African food crops (Hendre et al 2019). Through collaborations with international and national genebanks and public-private initiatives, 101 African orphan species have been prioritized to be improved and mainstreamed into African food systems. Additionally, certain CGIAR centers also have a mandate to conserve orphan crops: AfricaRice on African rice (*Oryza* glaberrima); the International Center for Agricultural Research in Dry Areas (ICARDA) on lentil and chickpea; ICRISAT on chickpea, pigeon pea, and pearl millet; IITA on banana, plantain, cassava, cowpea, and yam; CIAT on beans and cassava; CIP on sweet potato; and ABC on banana (Tadele 2019; CGIAR 2022b). Through focused conservation on orphan crops, international genebanks are also able to adhere to and consider the needs of smallholder farmers and marginalized groups, who often rely on these crops.

Moreover, international genebanks often have monitoring, data, and quality management systems and other institutions in place to ensure high quality accessions (Lusty et al. 2021). For example, for decades the CGIAR genebanks have produced high material viability for the various crops and forage species (Hay et al. 2021, Galluzzi et al. 2016). Further, a large percentage of all accessions is readily available, and safety duplication is pursued to store the material in several places (Halewood et al. 2020, Galluzzi et al. 2016). The authors also state that the quality and relevance of the accession-level information made available by the CGIAR centers is one of the most important factors in determining demand for PGRFA.

### National genebanks

National genebanks often connect more directly with farmers than international genebanks, however the degree of the direct interaction is dependent on the available resources, funding, conserved crops, and region. National genebanks are generally more equipped with knowledge about the specific needs and constraints of marginalized groups in the country, and often even have direct contact with community seedbanks or farmers through outreach programs and seed sharing initiatives. They also can have a larger crop portfolio as they are usually not focusing on the gene pool of a particular staple crop as the CGIAR genebanks do for example due to their mandate (FAO 2009a). This allows national genebanks to be more flexible in conservation and thereby cater to the specific needs of their region.

There are also successful examples of reintroduction with national genebanks, one being the transfer of seed to Krahô Indigenous farmers in Brazil from the Brazilian Agricultural Research Corporation (Embrapa) (Westengen et al. 2018). Successful inclusion of smallholder farmers by national genebanks can be also seen through several examples in Africa, namely Zimbabwe, Nigeria, Ethiopia, and Kenya, as well as in Bangladesh and Nepal (Vernooy et al. 2022). Often the connection is more through international that work with national genebanks and also more directly with the farmers. For example, the *Seed Savers Network* in Kenya is an initiative to strengthen community seed systems and works directly with the national genebank to do seed exchange and capacity building (Wanjama 2022).

International institutes and NGOs are also able to collaborate with national genebanks, for example, the Crop Trust led project *Seeds for Resilience* that works with the national genebanks of Ethiopia, Ghana, Kenya, Nigeria, and Zambia to provide technical and financial support in maintaining and distributing their collections (Crop Trust 2019). In other instances, international NGOs collaborate with national and international genebanks to facilitate emergency seed intervention (CIAT 2011). Additionally, the degree to which national genebanks can collaborate with farmers is dependent on legal frameworks, which is why national genebank heads and NGOs continue to call for recognition of community seedbanks in policy, so as to advance funding opportunities between national genebanks and the larger farming community (Joshi et al. 2018). National genebank networks, oftentimes, have the resources, relationships, and capacities to support the needs of their marginalized communities. This is often dependent on the national political involvement, and the degree to which conservation is prioritized and farmers' rights are discussed.

Ethiopia, for example, is considered a country with one of the richest collections of genetic resources in the world, and a large majority being indigenous landraces (Kasso and Balakrishnan 2013). Ethiopia is also recognized as a state that prioritizes complementary *in situ* and *ex situ* conservation practices, and formal seed system development at the forefront of promoting access and farmer inclusion (Mulesa et al. 2020; Kasso and Balakrishnan 2013), with PGRFA being a high topic on the political agenda (Vernooy et al. 2015). There is a strong network between the Ethiopian Biodiversity Institute, and public agricultural research and development institutions, and beginning in the late 1980s, the institute focused on *in situ* management of PGRFA to strengthen farmer seed systems and further support farmer and breeders' rights (Mulesa et al. 2020). Additionally, the country has a reputation for distributing more seed internally than providing samples to foreign researchers (Fowler and Hodgkin 2004), as well as having generally less involvement from multinational seed companies (Scoones and Thompson 2011). Another example of successful inclusion, and an example of combining national and local genebank efforts, is the PPB program through the locally developed genebanks in Ethiopia, where women are active and key participants in developing crop varieties in the genebanks (Njuguna-Mungai et al. 2022). The focus of this project as well is on protecting the livelihoods of vulnerable women farmers specifically and is a collaborative effort with scientists and researchers (Gotor et al. 2021). The project also seeks to document Indigenous knowledge of farm methods, including selection, cultivation, and use of crops, as well as women specific knowledge of seed preservation, exchange, and movement (Mulesa 2022).

In Zimbabwe, the relationship between community seedbanks and the national genebank is strong and interdependent, with seed collections starting at the level of community seed banks and then being archived at a national and regional level. First it is safeguarded at the Genetic Resources and Biotechnology Institute, which houses the national genebank of Zimbabwe, and later at the regional Southern African Development Community Plant Genetic Resource Center in Zambia. The genebanks and seedbanks conserve collections of orphan crops, such as indigenous pearl millet, Bambara groundnut, cowpeas, and a variety of indigenous vegetables, with farmers donating, sharing, and borrowing seed from the banks as well as from the larger farming network (African Centre for Biodiversity 2019). Zimbabwe's national system of conservation, and how it is also integrated into the larger regional and international system, is a strong example of active collaborations with NGOs, farmers, scientists, and policy actors in conservation efforts and climate change adaptation improvements to genetic material (Nkhoma and Otieno 2017).

The South African government and national genebank have also facilitated a network of community seedbanks that enable farmers to not only access seed and strengthen the overall seed system, but also participate in national-level decisions related to sustainable use of PGRFA (Nankya et al. 2022).

National genebanks naturally differ in which orphan crops they conserve and to what degree, largely due to resources, research, and funding, as well as the state's position on PGRFA conservation and the types of crops in the given areas (Tadele 2019). Regarding small millet and pseudo cereals, for example, the national genebanks that are major repositories for them are China, the USA, and India (Talabi et al. 2022), however these are also conserved to various degrees in other countries, depending on their local dependence and traits. This is also seen in the national priorities and research availability for specific orphan crops. For example, in Ethiopia wheat is conserved as a major crop, while teff (*Eragrostis tef*) is an orphan crop with local importance. There are 40% more teff farmers and 70% more land farmed with teff in Ethiopia than wheat, however the total yearly production of teff in Ethiopia (4.5 million tons) is only 7% higher than yearly wheat production (4.2 million tons). This gap is due to different farm endowments and shows a general research and resource priority for major staple or cash crops such as wheat, despite the higher local demand for orphan crops such as teff (Tadele 2019). Further, in China, the Chinese yam (*Dioscorea polystachya),* cultivated for centuries in East Asia, has recently been provided more extensive research as an orphan crop and neglected species for food security in Asia and potentially in Europe as well. However, yam research continues to be scarce, particularly in the Western world, despite the potential benefits of this orphan crop. This serves to highlight further that while orphan crops are on the national and regional radar as having strong potential for food security, there are large gaps in furthering the research and development of such initiatives cross-nationally and nationally (Epping and Laibach 2020). Institutions storing orphan crops *ex situ* therefore provide an important reservoir of genetic diversity to improve and disseminate orphan crops. Additionally, it is noted that there is vastly more information available about research on and development of orphan crops in Africa than any other world region. This highlights an awareness and general research priority towards advancing and using orphan crops in food security in Africa, despite the overall gaps in resources.

The regional network of conservation and national genebanks in Africa is robust and relies on international collaborations with national NGOs as well as community seed networks to facilitate a comprehensive PGRFA saving and sharing framework. This can be seen in the *Protocol for Collaboration* between national genebanks and community seedbanks as drafted by NGOs from Zimbabwe and Uganda as well as ABC of the CGIAR and the Wageningen Center for Development Innovation (ISSD Africa 2021). These regional conservation systems are farmer focused and rely on active trust and engagement between national actors and communities, thus enforcing a knowledge sharing system (Kimani et al. 2021).

This is not to say there are no national barriers in place that can hinder the degree to which seed is shared by various actors, depending on formal seed system regulations. For example, despite Ethiopia's strong farmer-led seed system approaches, government-led formalization efforts continue to sideline opportunities to tap into a more inclusive seed sharing system, particularly for rural, poor smallholder farmers (Mulesa 2021). Another example is Kenya's efforts to streamline a formalized seed system through the enaction of laws and regulations prohibiting the sharing of uncertified seed, which continues to be met by farmers and non-governmental actors with skepticism as certified seed can often be expensive and therefore difficult to access (Croft et al. 2017). All of this is to say that again, there cannot be a one size fits all protocol for how to best reach marginalized groups, as the national legal, institutions and environmental frameworks play a strong role in what is possible and what constraints are present.

### Community seedbanks

Community seedbanks can be an active form of community engagement, economic support, and inclusion for farmers and marginalized groups. They are most successful when communities have autonomy over their local seed system and are utilizing their specific skills and knowledge to support its growth. Community seedbanks and community seed sharing have existed for generations throughout all the world's regions in various forms, either through home storage systems where seed was shared, or through more organized formal community seed storage centers (Vernooy et al. 2015). These systems can be highly inclusive of marginalized groups if they are made by and for them, with the needs and knowledge of marginalized groups at the forefront of the bank's development and function. While there are degrees of marginalization present within communities, for example, limited access to land and resources for young people and women, community organized conservation has the potential to, and is often successful at, integrating community members and their needs because they are actively participating in some form (Vernooy et al. 2020).These community resources are often more easily accessible for women specifically, as they are usually located closer to their residence as other institutions of *ex situ* conservation. A study on community seedbanks in Ethiopia also found that they are an outlet for equal access to seed for men and women, with women often participating more in the seedbanks (Wasswa et al. 2015). Additionally, by creating and maintaining a network of women seed custodians within the community, women feel more represented, less intimidated, and more empowered to participate with other women present (Vernooy et al. 2015). An example of this is the *Nayakrishi network of community seedbanks* in Bangladesh, a successful network of women who are experienced and skilled in seed preservation and germination overseeing local seedbanks. The program builds upon the farmer and the 'farm as the focal point' of *in situ* and *ex situ* conservation and is reliant on women community members to organize and run the seedbank (Bioversity 2018). Furthermore, farmers are most likely to access new seed through their community, as roughly 60-90 % of the seeds on which smallholder farmers depend is either saved on-farm or precured through local distribution channels, whether that be through community seed sharing systems or simply exchanges between farmers (Song et al. 2021).

Community seedbanks are continuing to be understood by national and international genebanks as an access point to engage with, hear from, and support smallholder farmers. While the potential to reach and support farmers through community seed systems is abundant, there are many challenges that prevent the full realization of their success, for example financial limitations, technical and organization capacity, as well as national policies and legal frameworks. Through their formal recognition, community seedbanks could access more funds and organizational support, as well as effectively address the needs and rights of farmers, as prescribed in the ITPGRFA (Westengen et al. 2018). Of course, community seedbanks must also take care to not act as institutions which further marginalize certain users through their activities if they are to be considered inclusive and beneficial for marginalized groups.

There are two common ways that community seedbanks are linked to and work with genebanks. The first is that genebanks can reintroduce varieties to be multiplied and managed in community seedbanks. The second is that community seedbanks identify cultivars on farmers' fields that are then sent to genebanks for long-term conservation. An example of this is Nepal, where over 100 community seedbanks exist for both conservation and market purposes (Westengen et al. 2018). The national genebank of Nepal, the National Agriculture Genetic Resources Center, regularly organizes meetings and communications with community seedbanks, while also supporting and strengthening management, and providing trainings on managing new crops. Additionally, the center has also requested community seedbanks to regenerate accessions of crops, such as rice, while providing the communities with seed samples and covering costs (Joshi et al. 2018).

# 4. Best practices, lessons-learnt and recommendations

This chapter first summarizes the selected presentation of best practices which were gathered during the desk and literature review as well as the expert interviews and are described in more detail above (section 4.1). Then it presents lessons-learnt (section 4.2) and recommendations (4.3) for strengthening the role of marginalized groups in *ex situ* conservation and making genebanks more inclusive. These offer a description and an assessment of options for improvements in the strategies of genebanks and other institutions of *ex situ* conservation that ensures better consideration of needs of marginalized groups in the smallholder farming sector.

## 4.1. Selected presentation of best practices

In this sub-chapter a selected presentation of relevant best practices is compiled. It reflects the work of institutions of *ex situ* conservation that consider the priorities and needs of marginalized groups in the smallholder farming sector in *ex situ* conservation of crop diversity and the use of these collections. The list below focuses on genebank activities which are directly aimed at improving the access and use of PGRFA by smallholder farmers or their food security. Again, it needs to be stressed that within the realm of this study, marginalized groups are seen as a specific subgroup of smallholder farmers (see section 2.1). Therefore, working directly with farmers is seen as an option for strengthening the role of marginalized groups and being more inclusive. This means that also inclusive actions, strategies, or resources of genebanks are showcased here even if they do not explicitly target marginalized groups, but smallholder farmers. Based on the research presented in this study, no institution of *ex situ* conservation has an explicit and published concept or strategy to include marginalized groups. Rather, genebanks attend requests for distribution when they are made by smallholder farmers or marginalized groups, and also work together with other actors to transfer material stored *ex situ* to farmers' seed systems. Hence, we present best practices which implicitly include smallholder farmers in marginal locations, women, or other marginalized groups. Please also note that this list cannot provide a comprehensive overview as we could not interview all genebanks and 43 % of the invited interviewees did not respond. Further, as this study focuses on the role of marginalized groups in *ex situ* conservation, we do not discuss indirect interactions such as distribution of genebank material to breeders who target marginalized groups through e.g., participatory breeding or varietal selection. Nevertheless, these indirect pathways allow marginalized groups to benefit from *ex situ* conservation.

Looking at the **international genebanks**, we would like to highlight the work of two genebanks that had direct interactions with smallholder farmers and also led these interactions:

- Repatriation of potato landraces in Peru carried out by the CIP genebank (Lüttringhaus et al. 2021). Here, Andean potato smallholder farmers are seen as marginalized, no further explicit strategy is implemented to specifically include women or young farmers. The CIP-genebank also repatriates other Andean minor crops and leads projects on sweetpotato reintroductions in Africa, specifically the *Seeds for Resilience project* (S4R) and the Darwin Initiative (Crop Trust 2019; Dulloo 2019).

- Rematriation of maize landraces by the CIMMYT genebank which distributes maize landraces to Mexican communities (Ocampo-Giraldo et al. 2020).

The above described two examples are from centers which are located very close to the center of origin of some crops they conserve (potato and maize) and therefore they are located close to the farmers who plant and conserve these PGRFA *in situ*.

Further, IITA redistributes *Seeds of Hope* directly to farmers after they lost material due to extreme events. The new CIAT genebank, *Future Seeds*, is also a good example of an open genebank that welcomes visitors and provides educational services to the interested public. There are many other projects within CGIAR centers which directly introduce PGRFA material to farmers and marginalized groups, but generally they are not genebank-led (please refer to Table 3 in the Annex).

Genebanks whose mandate it is to conserve orphan crops, such as AfricaRice safeguarding the indigenous African rice *Oryza glaberrima*, have a good starting point to include marginalized groups, as these are often important staple crops for marginalized groups.

Talking to PGRFA experts, we identified the following **national genebanks** to have a specific strategy to reach marginalized groups and hence strengthen their role in *ex situ* conservation:

- National genebanks, for example in Zimbabwe, Ethiopia, Kenya, and Uganda, which coordinate activities with other stakeholders (e.g., community seedbanks, extension services), which are crucial for them to directly reach farmers.

- Some national genebanks such as the ones in Benin and Albania commission farmers to carry out seed production or multiplication of genebank material.

Depending on their setup and activities, **community seedbanks** can be deeply connected with local communities and also marginalized groups.

- The community seedbanks in Zimbabwe, Kenya, Uganda, Nigeria, Ethiopia, Nepal, and China work well and conserve a lot of material. Except for China, these are also connected to associations which strengthen the role of the seedbanks. The communities in the African countries listed above have ownership of the seedbanks and can therefore directly cater to their own needs as far as the seedbanks' resources allow.

- The community seedbank network Seed Savers Network in Kenya created a farmer-to-farmer seed exchange platform, where farmers can contact colleagues who have certain material. Payment works via mobile money.

- The Biodiversity Education and Resource Center in Nigeria assists farming communities in developing home gardens and community seedbanks to conserve, restore, and revitalize crop varieties and share seed. The center is community-led, and all decisions are taken by the communities with the advice of scientists and PGRFA experts if needed.

- The Nayakrishi network of community seedbanks in Bangladesh that is led by women who manage and facilitate the sharing of seed, as well as conserve it (Bioversity 2018).

Another best practice for connecting and integrating farmers within the larger seed system network is the African regional system. The collaborations that African country genebanks maintain with international genebanks, NGOs, community seedbanks, and farmers directly is an example of an integrative seed system that could be emulated in redesigning how international and national genebanks can work together to support the needs of smallholder famers and marginalized groups. This is largely due to the proactive ways that many African countries protect and address farmer rights, which in turn encourage the sharing of seed.

## 4.2. Lessons-learnt

This sub-chapter presents lessons-learnt on how to integrate the needs and priorities of marginalized groups in *ex situ* conservation, strengthen their role, and promote the use of PGRFA. Interviewees agreed that there are no risks in integrating marginalized groups in their work and strategies. Nevertheless, a lack of funding, resources, staff, and time are impediments to being more inclusive of the needs and priorities of marginalized groups. Therefore, the following lessons-learnt, drawn from the experiences of interviewees with respect to marginalized groups as well as the usage and conservation of PGRFA, show what was important and helpful in the past to reach marginalized groups.

- **Establish good and trustful relationships between genebanks and marginalized groups.**

It is important to take time to establish these relations. This can be best achieved through long running activities, as seen for example in the CIP repatriation program, which started with a request by farmers in the 1990’s to the principal potato landrace curator to evaluate the diversity of their potato portfolio (Lüttringhaus et al. 2021). Since then, the activities have continued, and farmers have spread information about it through word of mouth. Such personal relationships between genebank staff and farmers are very helpful for growing the foundation of connections and reciprocity with marginalized groups. Local staff are usually well-equipped to reach out to local farmers, as they are often more familiar with the culture and norms than, for example, international consultants. To establish good and trustful relationships, it is further important to demonstrate that the exchange is reciprocal, that it is a give and take. This means that e.g., during collection missions not only the genebanks receive material from the farmers, but also that the genebanks inform farmers about the processes and conservation efforts of the genebank, and how farmers can obtain further information and material from the genebanks. Additionally, the benefit sharing created by the Convention on Biological Diversity and Nagoya Protocol, is an important mechanism to establish trustful relationships. A trustful relationship is an important precondition for collaboration, especially when working with communities who are wary of depositing PGRFA to a genebank.

- **Show and promote the usefulness of *ex situ* conservation.**

*Ex situ* conservation institutions hold vast amounts of diversity, and their objective is to conserve the material for long periods of time. Therefore, certain material might not be used in the near future. This is one reason why genebanks were referred to as ‘seed morgues’ in the late 1990's (Raeburn 1995), and why it is important to also explain to the public what genebanks do, why they are important, and how they can serve farmers. Marginalized groups can benefit from *ex situ* conservation by receiving useful material and data as well as other services from genebanks. Such material and data could, for example, improve a specific group's food security and livelihood when they receive material which is suitable for their farmland, produces better or more constant yields, or has nutritional advantages. Marginalized groups can only take advantage of the material and data stored *ex situ* when they can access it. To request material directly from genebanks, it is necessary that farmers, including marginalized groups, know that genebanks exist and how they can contact them. Further intermediaries such as national research or extension services could also provide the material to marginalized groups. Additionally, in this case it is beneficial for farmers to know about *ex situ* conservation because they might want to deposit material to be safeguarded or use another service.

- **Support farmers in testing and examining material collected *ex situ*.**

Farmers are very interested in testing new material. Hence, they should be integrated into genebank activities and outreach, so that they can be a part of the testing processes. Their participation should be supported by e.g., proactively inviting them, providing transport, putting written information on testing sites, hosting guided field visits, or creating testing sites near the residences of marginalized groups.

- **Maintain and scale up the interdisciplinary and integrative approach of participatory plant breeding.**

PPB can be seen as a successful movement in facilitating real farmer involvement and understanding their needs. As the approach has been successful in creating varieties with traits desired by farmers for often marginalized environments, it is important to uphold the principles of interdisciplinarity and inclusiveness when conducting PPB-activities. Some interviewees feared that ill-designed PPB-projects might integrate farmers' perception in a very limited way or at a very late stage, and hence not live up to the principles for which PPB was created.

- **Promote the benefit to the overall community when targeting a specific marginalized group.**

When considering gender as a focal point for a project, for example, it is important to reiterate to the larger community how this promotes and supports every person, and that by including women's needs, priorities, and skills, the community at large can benefit. Using language that further separates people could be harmful, both for the success of the initiatives, but also for the individuals themselves. This is not to say it is always easy to include marginalized groups in programs, in fact there remains much that can be done to further their participation. For example, in Syria, women farmers struggled to be involved in the PPB program because the male farmers were accustomed to working solely with other men and did not allow female participation (Puskur et al. 2021). Therefore, it is not enough to simply construct these types of programs. Genebanks and affiliated organizations and governments must also consider the specific circumstances at an intervention area and further put into effect procedures that account for potential pushback against gender inclusion, as well as stress the overall community benefit of including women (Nchanji et al. 2020).

- **Use inclusive language and be aware of social and gender dynamics when designing and implementing projects.**

This is so that specific groups know and feel that they are included in outreach and project initiatives, and so that outreach efforts do not miss certain demographics simply because of unclear wording, or because trainings and projects at led at inconvenient times for specific groups. For example, young mothers do not identify as youth nor adult farmers. Hence, they would not feel invited when an *ex situ* conservation institution searches for projects participants labeled in that manner. It is further important to be aware of cultural and societal rules when designing direct use projects (e.g., respecting women's schedules to enable their participation).
Another important factor when planning and implementing projects is to be aware of the specific roles of women in agriculture. According to the literature and project experiences, it is very well established that women have an important role in agriculture and family food security. Therefore, it is now time to move forward and produce tangible results that implement these observations. This means considering these specific roles and how these critically contribute to biodiversity conservation when designing and implementing projects.

- **Recognize Indigenous and traditional knowledge.**

It is crucial to respect and recognize the importance of Indigenous and traditional knowledge in crop diversity and farming techniques and include this knowledge and input when designing projects and facilitating collections. Indigenous knowledge is often passed down through generations of farming communities and is specific to the region's people, the environment and the PGRFA which evolved therein. To protect this knowledge and the people that hold it, particular attention should be made to the legal frameworks surrounding information rights, specifically the Nagoya Protocol of the Convention on Biological Diversity regarding efforts to minimize exploitation of Indigenous groups in conservation of biodiversity. Additionally, national governments are encouraged to develop their own legal frameworks surrounding safeguarding Indigenous knowledge. For example, in 2019 South Africa published the Protection, Development, and Management of Indigenous Knowledge Act which explicitly provides for the protection of Indigenous knowledge from unauthorized and misappropriated use, as well as provides an outline for registering, cataloguing, documenting, and recording Indigenous knowledge (Republic of South Africa 2019; FAOLEX 2019). Legal frameworks such as this have successfully started formalization efforts on a national level, which in many ways is as important if not more important than international legal instruments. This is because domestic legal instruments work within a smaller, more direct and context specific scale, and are built with measures to enforce the acts themselves.

- **Engage youth proactively in PGRFA use and conservation efforts.**

Including youth is crucial for the sustainability of project objectives, as youth are the future of farming and culture. Therefore, it is important to engage them in PGRFA use and conservation efforts through targeted approaches. Activities which worked well in the context of the CIP-led ANDEAN project are, for example, connecting citizen science platforms with competitions for a tablet or similar. This encouraged young people in Peru talk to their older family members about agrobiodiversity and the cultivars their family's conserve; if they entered diversity data in the platform they participated in the lottery. Due to the technological affinity of the new generations, it also advisable to use smartphone applications to connect with them. Another successful option was to include potato landraces in the school curriculum, for example, by using landrace diversity to teach mathematics, linguistics, or other topics.

## 4.3. Recommendations with actionable activities

The following section describes recommendations to strengthen the role of marginalized groups in *ex situ* conservation and connect this form of conservation with farmers' seed systems. Further, it will present actionable activities that suggest ways in which the recommendations can be implemented by the Crop Trust, partner genebanks, and other institutions of *ex situ* conservation. These recommendations are to guide how to better consider the needs and priorities of marginalized groups in *ex situ* conservation and the use of conserved genetic resources, for example, during planning and joint resource mobilization efforts with international, regional, or national genebanks. It is important to note that the different stakeholders of the global system of PGRFA conservation are very heterogenous (see also a definition of these institutions in the annex) and for these reasons they carry out different types of work and services, operate in different environments, and therefore have different user groups, resources etc. As a consequence, no generalizable plan of actionable activities can be drawn up for the different stakeholders such as international, regional, and national genebanks, but if suitable options are given.

The recommendations and actionable activities are derived from desk and literature research as well as the interviews conducted with experts in the field. This research revealed best practices, intentions, and assumptions as well as corresponding recommendations for application. Before describing the recommendations, it is important to note that a precondition for their validity is the secured access by marginalized groups to material stored *ex situ*. If farmers cannot access the material, their role, and in particular the role of marginalized groups in *ex situ* conservation, is limited.

- **Create an inclusive and farmer-led system of PGRFA conservation, exchange, and use.**

When conducting the expert interviews, this recommendation and vision for the future was mentioned in various forms by most of the interviewees. The most important sentiment behind this recommendation is to not only see farmers as end-users in the standard flow of PGRFA from genebanks to breeders and then to farmers. Rather, the innovations and technologies should be designed for farmers as the principal users and conservers of PGRFA. It should not be the case that the users must adapt to a technology. This implies that farmers and also all other stakeholders within the PGRFA system (breeders, institutions of *ex situ* conservation, extension services, research institutions, processors, consumers etc.) must be considered and given a voice in the farmer-led system. Such an inclusive and farmer-led system could also allow coordinated actions between the informal and formal seed sector (Sperling et al. 2013), which are both important for supplying farmers with suitable material. In comparison to farmers who farm on high-potential areas with high input quantities, smallholder farmers, and more specifically marginalized groups, often rely on the informal seed sector and also farm on marginalized land. Therefore, they might have different needs and options than non-subsistence farmers when it comes to accessing PGRFA. Given these differences, they would particularly benefit from a farmer-led PGRFA system if they are included in it.

To ensure that the needs and knowledge of marginalized groups are actively represented in projects, marginalized farmers and social scientists should be included at an early project stage when projects are designed. Inclusion, knowledge sharing, and addressing the logistical, economic, and social barriers that marginalized groups face in accessing genebanks are the foremost recommended actions to integrate the needs of marginalized groups. This would mean, for example, that marginalized groups could voice their needs when it comes to breeding new varieties and that breeders would then integrate these in their work. Marginalized farmers should be given a voice and also the capacity for self-representation. To this end, farmers could be trained on how to present their ideas to a scientific forum, as well as provided access to do so. To this end, institutions conserving PGRFA and those working with marginalized groups should provide such capacity development and adapt it to the needs of marginalized groups. For example, when organizing training or educational seminars, considering the time and physical constraints that marginalized groups face due to their roles in the family and community, might facilitate their participation more. In other words, it would ease their participation if the sessions were not a far distance, if transportation was provided, and if they were held at a convenient time. Such capacity building would also allow to connect different actors of PGRFA conservation and use.

A holistic integration of stakeholders would also create more diversity of ideas and specific knowledge. This inclusive and farmer-led consortia or web of PGRFA conservation, exchange, and use should also be democratic to bridge the gap between scientific and traditional knowledge. This would create an exchange which would benefit both marginalized groups and scientists, as well as other stakeholders. Furthermore, this idea is dependent on the notion that farmers are also breeders and should, again, not be regarded simply as the end-users in the material flow.

It can also be an objective of the system described here to revive food systems. PGRFA also carry cultural values and are therefore highly important to communities. It should be their decision how a food system should evolve, as certain cultivars have cultural value or maintain a generational history that is important for communities to pass on and preserve. Given national legislation, contexts, culture etc. it is crucial for every *ex situ* conservation institution to understand what kind of seed system is possible in their mandated region or the region where the conserved crops are grown. Hence, there is not one size fits all solution, but each genebank must elaborate their own realm of possibilities. This discussion should be done internally and externally with other stakeholders within the global system of *ex situ* conservation (see next recommendation).

- **Discuss within the global system of *ex situ* conservation how to include and reach marginalized groups.**

This recommendation is closely related to the previous one, but here, the question is who is best equipped to cater to the PGRFA-related needs of a marginalized group in a specific context and region. Agricultural systems and markets, as well as the flows of PGRFA, vary from region to region as they depend on many factors such as infrastructure, national regulations, and institutions (e.g., genebanks, community seedbank, extension services, NARS) and the presence of international collections. Furthermore, marginalization and also the appropriate inclusion depends on many factors involving context, region, and time. Therefore, it is not possible to draw a general global recommendation on who should strengthen the role of marginalized groups in *ex situ* conservation. Depending on the specific context, the global, regional, or national system might be best equipped to strengthen the role of a specific marginalized group in *ex situ* conservation. For example, given certain conditions, national extension services, research institutes, community leaders, genebanks, or other stakeholders might be more suitable to reach a marginalized group than international or regional institutions. This is because the staff in a national system might speak local languages, have more context-specific knowledge about traditions and customs, and also be aware of which PGRFA would be useful for marginalized groups and how these resources can be accessed. Furthermore, experts in the local system are usually located more closely to the marginalized groups within a specific country. But if, for example, a national genebank does not have sufficient resources to connect with marginalized groups, then it would be beneficial for marginal groups if other stakeholders within the national, regional, or global *ex situ* conservation system took on the task of integrating the needs and priorities of marginalized groups in *ex situ* conservation and strengthening their role. Collaboration, exchange, and discussion within the global system is also key to take advantage of each player's strengths and use them to include marginalized groups. Currently, global knowledge exchange, capacity building etc. is already improving *ex situ* conservation around the world. Marginalized users of PGRFA can benefit from these activities as they might improve the diversity, quality and quantity of accessions, availability of data, and other factors facilitating use and selection.

A global institution or group would be a good moderator of such a discussion and exchange within the global system. To this end, a consultative group with representatives of all types of *ex situ* conservation institutions could be formed. This process could be initiated by the Crop Trust or the CGIAR genebank platform through project calls or other means.

Furthermore, the recognition that marginalized groups also have relevant knowledge to advise and support institutions of *ex situ* conservation in the curation of their collections is also an avenue for direct collaboration and should be explored further.

Given that most institutions of *ex situ* conservation currently focus on the core activities of conservation and characterization, and given limited funding and resources, it will be a difficult task for genebanks to select and interact directly with marginalized groups in a meaningful and sustainable way. Hence, it is more realistic to create international, national, and regional networks of stakeholders who can jointly strengthen the role of marginalized groups and identify their needs and roles in each context. To this end, it must be investigated regularly who is marginalized within a specific context and what PGRFA-related needs they have. A precondition for such a discussion is an actionable activity that each institution of *ex situ* conservation starts an internal process elaborating on who might be considered as marginalized within its mandate, and which resources it holds that could be useful for them.

- **Prioritize the conservation and characterization of PGRFA for marginalized groups and close gaps in the conservation of orphan crops and CWR.**

To best include the needs and priorities of marginalized groups in *ex situ* conservation of PGRFA, genebanks and institutions of *ex situ* conservation must conserve and make accessible genetic resources that are beneficial for and preferred by marginalized groups. This will vary regionally, as trait preferences as not universal nor are agricultural needs or roles, and therefore requires genebanks or the institutions acting as intermediaries between *ex situ* conservation and marginalized groups to understand who is marginalized within their mandate and what their priorities are. In doing so, genebanks should also further assess conservation gaps.

Generally, PGRFA with specific nutritious or agronomic traits such as resistances and tolerances can be very helpful for marginalized groups if they can grow in their areas and meet their culinary, cultural, agricultural, and economic conditions. For example, orphan crops are particularly valuable for marginalized groups, and therefore genebanks would improve their inclusiveness by safeguarding more of these crops. Further the conservation of CWR can be beneficial for marginalized groups through its added diversity and potential in aiding climate change adaptation. It is also important that genebanks maintain awareness that the priorities of marginalized groups will continue to change, as well as relevant preferences, and it is necessary to maintain some form of direct contact with marginalized farmers so that genebanks can continue prioritizing fitting PGRFA for them. This is a continuous actionable activity which should be pursued by all institutions of *ex situ* conservation.

- **Characterize the complete accessions of genebanks, use and improve genebank information systems, and make the data publicly available.**

To bridge conservation and use of PGRFA, a big facilitator is the thorough characterization of the material stored in genebanks (Fadda et al. 2020). To distribute the best fitting material to marginalized groups and other users, it is necessary to know it well. For providing more useful accessions and data to marginalized groups, genebanks should characterize a maximum of their accessions and assess their agronomic and nutritional traits as well as other traits in the interest of smallholder farmers and marginal groups.

The lack of accession-level data is a major hurdle for the use of PGRFA (Halewood et al. 2020, Thormann et al. 2012). Having more availability and access to data would help marginalized groups and other users of genebanks, such as breeders, to potentially use larger diversity for their work and find suitable crossing partners. This would in turn help marginalized groups in the medium term if they can access and adopt improved material which better caters to their needs and priorities. For this to happen, more funding and resources are needed. However, this process could also be a part of the global effort to reduce redundancies or duplicates in genebanks all around the world. Such a reduction would reduce genebank costs and could therefore provide the opportunity to concentrate on further activities or accessions such as integrating marginalized groups. An improved characterization of the material would, in this way, also support climate change adaptation strategies. When more is known about each accession, material for adapting PGRFA to climatic changes can be found. Furthermore, Indigenous knowledge regarding PGRFA should be documented, safeguarded, and distributed in tandem with accessions, with the names of the ethnic groups or tribes also included in the data. This is both to preserve traditional knowledge about agrobiodiversity as it is increasingly being lost to time, as well as promote and preserve the longstanding farming innovation systems of Indigenous communities and acknowledge their contribution.

Genebank information systems have the potential to be utilized as a resource for all user groups including marginalized groups in accessing and understanding what PGRFA are available and where, especially as the international agricultural community continues to fix intention on facilitating a wider global system of information. An option to generate and include specific data on marginalized groups, e.g., gender-differentiated data, would be to establish and use protocols or guidelines for sharing data on relevant characteristics within institutions of *ex situ* conservation. The usefulness and usage of such data could be enhanced when integrating filters with which users can sort all accessions (e.g., cooking characteristics important for women).

However, all interviewees were asked which genebank information systems they are using or what type of data could be useful for marginalized groups, and genebank information systems were not mentioned. In the literature only two publications that expanded on the roles and current situation of genebank information systems in the larger global system were found (Weise et al. 2020; Mekonnen and Spielman 2021). However, there was no focus or mention of topics relevant for this report (e.g., farmers, gender-responsive breeding, or orphan crops). As it stands presently, there does not seem to be any specific resource within genebank information systems that is facilitated for marginalized groups. This implies further need for research on how such systems could help genebanks to improve their work generally (actionable activity) and also take into account the priorities and needs of marginalized groups (actionable activity).

- **Implement and test options to collaborate with marginalized groups.**

Drawing on the above-explained lessons-learnt, institutions of *ex situ* conservation should engage marginalized groups in their work and strategies. Such a collaboration can be beneficial for both genebanks and marginalized groups, as it allows a reciprocal exchange of knowledge, experiences, and material. Without direct forms of interaction, mutual learning and exchange cannot take place. Further, such work can improve the food and nutrition security of marginalized farmers, hence contributing to Sustainable Development Goals and other frameworks. To this end, institutions of *ex situ* conservation could implement and test options to connect to and collaborate with marginalized groups. Farmer field days, demonstration fields during material multiplication, as well as diversity fairs or direct distributions would be actionable activities of direct contact which can be well-integrated into genebank routines.

To integrate this form of collaboration in genebank strategies, it might be useful to include it as one performance indicator against which genebanks are assessed regularly (e.g., number of services offered for disfavored groups or regions, number of research publications on the topic). Of course, it is also important to consider the second recommendation when planning and implementing such activities of direct interaction. Depending on the context, international, regional, or national institutions might be better equipped to implement direct collaboration with marginalized groups. When farmers receive genebank material, its quantity can be a problem as genebanks usually cannot provide much seed, tubers, or other planting material due to resource limitations. Hence, it is crucial that farmers or communities have the capacities and knowledge to multiply the material received from *ex situ* conservation. Genebanks could develop manuals and procedures to evaluate farmers' ability to multiply and provide important knowledge for multiplication if needed.

- **Promote the purpose and existence of *ex situ* conservation.**

Farmers, marginalized groups, and other intended user groups of *ex situ* conservation must know about their existence, purpose, and useful services to make collaboration successful and mutually beneficial. Most farmers, and even more marginalized users of PGRFA who often have limited access to information and education, and have little to no knowledge of genebanks, even though they are one of the intended user groups. Therefore, the purpose and existence of genebanks should be marketed to them. Currently, the Crop Trust especially promotes the importance of PGRFA as well as their *ex situ* conservation through social media posts on LinkedIn or Twitter as well as through the organization of further events, such as cooking evenings, parliamentary breakfasts etc. However, these events are not explicitly geared towards the participation of marginalized groups, and therefore more effort must be taken to reach marginalized groups. Depending on the national and regional context this can be done directly by genebanks or through intermediaries such as extension service agents or inclusion in school curricula. This would imply that marginalized farmers can choose for themselves if they are interested in any PGRFA and if they want to request it at a genebank, which is also an important condition to create an inclusive, and equitable farmer-led seed system. Furthermore, each *ex situ* conservation institution should further promote its services in their mandated area. A good starting point would be to have a well findable, good quality and up to date homepage which describes the genebank resources and provides contact details. Such a description of the work of genebanks should also include general education on the importance and benefit of PGRFA for the general public. This actionable activity should be pursued by all institutions of *ex situ* conservation.

Further, genebanks should welcome and encourage visitors. Ideally, a genebank visit should be a broader educational and cultural experience where visitors see what the genebank is doing, learn about specific farming systems and crops, and where they might also taste dishes made of the conserved crops.

- **Expand the roles and mandates of institutions of *ex situ* conservation.**

Such an expansion should be realized in a way that institutions of *ex situ* conservation also carry out research beyond their core activities and work directly with marginalized groups or support intermediaries in doing so. This should also imply that genebanks could carry out impact assessments regarding their activities. For this purpose, genebanks and their possible superordinate organizations should elaborate on why this is beneficial for the genebank and organization. Such an expansion also needs recognition and support at the level of institutions funding *ex situ* conservation. Targeted project calls and other funding mechanisms should be supported and elaborated by funding institutions such as the Crop Trust.

- **Connect institutions of *ex situ* conservation with social science and gender experts.**

To follow the above recommendation, many interviewed experts mentioned that it is time to start connecting genebanks with gender and social studies. For example, when looking at the CGIAR system, we highly recommend starting a discussion led by the CGIAR gender platform and genebanks jointly. This discussion should also seek to broadly implement protocols to include interdisciplinary and intersectional (e.g., gender studies) perspectives at the very beginning of project proposals and their implementation. As the inclusion of marginalized groups is very context-specific, local, and interdisciplinary knowledge is required. The action of pursuing interdisciplinary research with a focus on marginalized groups should be supported by targeted project calls or other funding mechanisms and be a prerequisite to plan and implement projects.

- **Diversify staff of genebanks.**

The connection of *ex situ* conservation to social sciences and gender studies can also be achieved by hiring genebank staff from different disciplines. When genebanks hire more diverse staff and train their staff on gender, marginalized groups etc., these aspects could be better integrated in the everyday work of genebanks. Further, having staff representing marginalized groups of the areas where the respective genebank crops are planted could further help to better understand the local conditions and create personal relationships with the communities.

- **Separate women and youth when considering the focus group of a project and identify their needs separately.**

According to the interviews with gender experts, oftentimes the needs and conditions for the marginalized groups women and youth are put in the same box. However, according to project experience it is important to differentiate the two and treat them differently. For example, to reach the youth, their specific interest in new technologies should be used to understand and engage with them. Women, on the other hand, have specific needs when it comes to extension service, trainings, fairs, field days etc. For example, specific attention should be given to the feasibility of participation for women. This can be done by facilitating transport to the events, bringing extension workers or representatives of community seed banks directly to women farmers, or organizing field days which are specifically designed for women.

- **Support community seedbanks in being multifunctional and better embedded in the *ex situ* network.**

Community seedbanks should provide more services than PGRFA conservation for communities. To make them especially useful and part of the communities, they should also be a meeting place, offer workshops, and carry out seed production etc. In this way, the community seedbanks would be sustainably embedded in the local seed systems. Additionally, incorporating community seedbanks into a more formalized network of conservation nationally would allow them to more readily access genebank accessions, and directly provide them to farmers. To do this, community seedbanks need to be folded into the national legal framework, to receive both organizational and financial support from the national governments and international organizations.

- **Designate more support and funding for institutions of *ex situ* conservation.**

Direct and indirect interaction with marginalized groups, conservation of relevant orphan crops, CWR and other crop gene pools, as well as an expansion of genebank activities to include marginalized groups, requires time and resources. Therefore, more funding is necessary as budgets are determined to fit genebanks' mandates, and except for community seedbanks, the mandates of *ex situ* conservation institutions (or the interpretation of the mandate) typically do not include collaborations with marginalized groups.
Additionally, to hire more staff, e.g., social scientists to implement impact assessments, further funding is necessary. In the case of community seedbanks, a great support would be providing them with a legal status. So far, community seedbanks have no official legal status, and this hinders their work in many aspects, as well as their access to funds. To make sure the additional funding is used to support marginalized groups, a performance indicator should be created to include inclusivity as an important area of work. This also implies that project calls require the inclusion of marginalized groups.

# 5. Summary and conclusion

Despite national and international targets and programs, hunger and malnutrition are still a scourge of humanity (WHO 2022). Having access to suitable and good-quality PGRFA is a vital cornerstone of agricultural production, especially for marginalized groups who often have less resources and access to formal seed systems or agronomic information. Since the beginning of agriculture, farmers have selected, bred, and conserved PGRFA to secure their food security and livelihoods. Therefore, they are the custodians of crop diversity. Next to *in situ* conservation, PGRFA can be also stored *ex situ* in gene- or seedbanks, or dynamically combining both conservation approaches. Currently there is more diversity of some crops stored *ex situ* than *in situ* (Halewood 2013). This underlines the importance of safeguarding PGRFA in different settings. As farmers play a crucial role in conserving PGRFA and are the main users of them, it is important to discuss their role in the *ex situ* conservation of PGRFA. Marginalized farmers, who within the context of this study are considered as a subgroup of smallholder farmers, also heavily rely on suitable PGRFA for their food security and livelihoods. Due to their contextually different, more limited access to specific resources and the intersectionality of characteristics leading to their marginalization, it is particularly important to strengthen their role in *ex situ* conservation Therefore, special attention is given to marginalized groups in this study, which investigates how the needs and priorities of marginalized groups can be better addressed in and through *ex situ* conservation. To this end it explores the following research questions:

- What is the role of marginalized groups in *ex situ* conservation of PGRFA?
- And how can this role be strengthened?

To set the ground for elaborating these research questions, first a concept of marginalized groups is described (see section 2.1). In the context of the conservation and use of PGRFA this study refers to marginalized groups as a subgroup of smallholder farmers who have less access to resources such as wealth, land, and education. Therefore, it is important to note that marginalization depends on the specific sector, culture, region, and time considered. Furthermore, marginalization is intersectional, meaning that a combination of characteristics attributed to a person can lead to marginalization. In this study, the author was asked to focus on three select groups of marginalized people, women, youth, and Indigenous people, as each group experiences different degrees of marginalization in their limitations of access. Women's roles in many cultures and societies allow them less decision-making power and agency, despite the select conservation knowledge women are often responsible for (Sood et al. 2015). Young people are often limited in accessing land and financial support, leading them to seek work outside of farming (HLPE 2021). Indigenous persons experience marginalization in their access to traditional landraces, technological development, and quality seed, despite their traditional farming knowledge (Mollins 2019). Oftentimes, in the context of genebank projects and also in the interviews conducted for this study, marginalized groups were referred to as one or a combination of female, Indigenous, rural, and impoverished. In this study also the general term *smallholder farmers* is used when referring to marginalized groups as, depending on the context and time, a certain subgroup of them can be marginalized and hence, they are the focus of this study.

In this study, the role of smallholder farmers and marginalized groups was explored by conducting 37 expert interviews with managers of *ex situ* collections, members of the Crop Trust Science Team, as well as experts on gender, *in situ* conservation, and other areas. Furthermore, a thorough desk and literature review was conducted to analyze the status quo in research and the inclusiveness of *ex situ* conservation institutions regarding marginalized groups (see section 2.2 for more information on the methods).

In general, marginalized farmers depend on the availability and access to good-quality and feasible planting material for their livelihoods as well as food and seed security (see section 3.1). This is particularly true in the absence of a formal seed system or market, which is one of the characteristics of marginalized areas. Furthermore, PGRFA also have cultural values that hold great traditional importance for different societies and must also be acknowledged and protected. Hereby, orphan crops play a particularly important role and therefore their conservation is important for strengthening the role and interest of marginalized groups in *ex situ* collections.

As described in the literature there are many options for how genebanks can work directly or indirectly with or for marginalized groups (Westengen et al. 2018; Vernooy et al. 2022). Firstly, institutions of *ex situ* conservation are repositories of PGRFA and accompanying accession-level data, which can be useful to marginalized groups now or in the future, and secondly, they are distributors who can distribute them directly or through intermediaries to marginalized groups (section 3.2). The first option for genebanks to strengthen the role of marginalized groups is to act as a repository. Being a repository of valuable PGRFA and data is the core activity of *ex situ* institutions, and also serves as a precondition for the second option, being a distributor. Marginalized groups cannot store all PGRFA which they might need, therefore *ex situ* collections are important institutions for them. The inclusiveness of these collections increases when they conserve crop gene pools and data (e.g., on agronomic and nutritional traits) which are useful and important to marginalized groups. Expanding genebank information systems and integrating resources in them, which are useful for marginalized groups, can be very helpful to make knowledge on traits etc. available. To this end data for and on marginalized groups (e.g., gender-differentiated data) must be generated and published in a ready to use format. Here, orphan crops that are highly utilized by marginalized groups and more localized are important. Considering the insurance and use value of PGRFA, a diverse and secure repository is crucial for climate change adaptation, for example also through the conservation of CWR and data which supports the search and use of specific traits. The second option for strengthening the role of marginalized groups in *ex situ* conservation is when the respective institutions distribute material to marginalized groups, directly or indirectly through intermediaries. This can be done through reintroduction, emergency seed intervention, variety introduction, PPB, community seedbanks, collection missions and integrative seed system approaches. The ways of direct interaction are determined by the specific institution's mandate, resources, and strategy, as well as the local conditions in which it operates (e.g., responsibilities of the national research system). Therefore, different genebanks can enable other forms of direct use. Depending on which stakeholder within the global system of *ex situ* conservation are best fit to cater to the needs of marginalized groups in a local context, intermediaries such as extension services, NGOs or breeders can also transfer the material from *ex situ* collections to farmers' seed systems.

The inclusiveness of institutions of *ex situ* conservation with respect to marginalized groups and how they strengthen their role varies depending on their mandate as well as the legal, political, and institutional framework they operate in (see section 3.3). To the knowledge of the author, no institution of *ex situ* conservation has an explicit and written down concept of who is marginalized within a genebank's mandate or how to strengthen the role of marginalized groups in *ex situ* conservation. Most genebank or germplasm managers referred to poor smallholder farmers in marginalized areas when asked who they think is marginalized when it comes to using and conserving PGRFA. Furthermore, a focus is put on women as a marginalized group, with gender being understood as binary. The intersectionality of marginalization was only recognized by some CGIAR gender specialists, but not by genebank managers. Therefore, it can be concluded that within the context of PGRFA conservation, marginalized groups are understood to be rural poor smallholder farmers. Genebanks have yet to consider who is marginalized within their specific mandate and how they (or intermediaries) can better consider and cater to the needs of marginalized groups.

International genebanks and many national genebanks focus on safeguarding large and high-quality collections and work rather indirectly with smallholder farmers or marginalized groups. Drawing on the expert interviews, this study concludes that most genebanks do not see their mandate to be integrating the needs of marginalized groups in their work or strategies, however, on a larger scale, smallholder farmers are included in genebank mandate interpretations. Smallholder farmers are seen as an (important) user group, but this does not imply the existence of specific programs or projects that cater to their needs. Farmers are welcome to request material and when they do so, they will receive it in a timely manner and in excellent quality. Nevertheless, such a request can only be done when several preconditions are fulfilled: Farmers, and particularly marginalized farmers, must know about genebanks, how to contact them, be literate, speak the required language, and have some understanding of the material they want to have. According to the interviewed genebank heads and experts there are little to no risks attached to directly working with farmers. Many interviewees expressed great interest and will in furthering direct work with marginalized groups as well as connecting genebank work with social and gender studies, as this would allow for a mutual exchange of knowledge and the utilization of various relevant expertise. Impediments to further this integration and inclusion are a lack of funding and consequently a lack of time, resources, and staff. Further, the conservation of orphan crops as an international and national priority is another important practice to strengthen the role of marginalized groups that is, again, contextually, and regionally specific, however is applicable globally. This can be seen in many countries in Africa, as well as the mandates of several international genebanks.

Most international genebanks do not work directly with marginalized groups and rather reply to requests made by them for direct distribution. As the CGIAR genebanks are currently the largest and most frequently accessed network of global *ex situ* collections (Smale and Jamora 2020), this section will mainly discuss interesting initiatives from the CGIAR genebanks. With respect to CGIAR genebanks, the provision of material to CGIAR-internal or external breeders, national genebanks, or research institutes is the most common approach for indirectly reaching farmers with the material stored *ex situ*. Hereby, PPB and participatory varietal selection can be a powerful way to integrate the needs of marginalized groups as early as possible. Finally, conserving indigenous and orphan crops is a task that has steadily grown in priority and importance both at the international and national scale, as a way to address the needs of marginalized communities as well as a way of developing climate change adaptation strategies, which is ultimately critical for global food security and moreover the food security of smallholder farmers. Based on the interviews, as well as the literature and desk review, only CIP (repatriation of potato landraces) and CIMMYT (rematriation of maize landraces) mentioned explicit and continuous activities with marginalized groups that are genebank-led. Nevertheless, these programs do not have a specific concept of which marginalized group to target, rather smallholder farmers in marginalized areas such as the Andes are seen as marginalized. Further, both genebanks are located within the center of origin of some of the crops they distribute (potatoes and maize). This locates them near the farmers who are reached by the activities and distinguishes them from other international genebanks. Each genebanks' individual role is strongly influenced by the crops conserved and its respective user groups. Additionally, the legal, political, and institutional frameworks in which the genebanks and centers operate shape the room for maneuvering that each genebank has (e.g., strength of national agricultural research system or national genebanks). Further, one objective of the CGIAR genebanks and centers is to support the national agricultural research system and, in doing so, create close collaboration and synergies. Genebanks are open to farmers but depending on the extent and conditions of national extension service programs, the conditions of direct distribution by international genebanks may be less beneficial. For example, farmers might receive other subsidies such as fertilizers along with seeds when the distribution is done by national institutions. National institutions may also have more knowledge, funding, and capacity to distribute and work directly with farmers. Furthermore, the reintroduced material might not survive on farmers' fields, even in its old center of origin, as the environmental conditions may have changed. When looking at further integrative activities among the CGIAR genebanks, the ICRAF genebank is distributing most accessions directly to farmers, of which some can be considered as marginalized. Furthermore, the international genebanks are generally a repository of diverse and high-quality material. The large collections of international genebanks conserve the material and data which is – to some extent – also kept by farmers, community seedbanks, national genebanks and other actors. Therefore, the mere existence of such genebanks as repositories of valuable PGRFA and data, protects food security and by extension can cater to the needs of marginalized groups in the short and especially in the long term. For example, national genebanks focus on the entirety of crops cultivated in that nation and do not focus on conserving the maximum diversity of one crop gene pool. In contrast, the diversity of crop gene pools in the international genebanks which focus on one or several mandate crops is larger. This means that helpful material to improve and adapt a crop might be stored in international collections located on another continent. Therefore, promoting the global system is vital to safeguard material in good quality in different places, make it available upon request to redistribute, and create improved varieties, etc. If certain material is lost on farmers' fields, the global system of *ex situ* conservation can reintroduce it.

National genebanks often connect more directly with farmers than international genebanks, but their degree of direct and indirect interaction is dependent on the availability of resources, funding, and other factors. Regarding national genebanks, specifically the integrative activities by the genebank in Zimbabwe were mentioned. This genebank is actively involved in capacitating intermediaries to work with smallholder farmers on the use and conservation of PGRFA. Additionally, the national seed framework of Ethiopia is highly farmer focused, with a strong network of NGOs and community seedbanks, as well as collaborative efforts with international genebanks and centers. Further the national genebanks in Benin and Albania commissioned farmers to multiply some of their material. National genebanks are also in some cases better equipped to address gaps in orphan crop conservation, as their collections can be more specific to the needs of their population and region. On the other hand, the collections of national genebanks can be more diverse than those of international genebank as they do not focus on specific mandate crops and can therefore store the whole portfolio of crop gene pools present in a region and also accompanying data such as trial results conducted in the region. For example, Africa as a region has demonstrated the highest priority to research and conserve orphan crops, and this is largely due to the dynamic regional and national networks in place. Also, national genebanks are usually closer to marginalized groups and possess more capacity to collaborate with them as their staff has more knowledge of the languages spoken, traditions in specific regions etc.

The role of marginalized groups in *ex situ* conservation by community seedbanks depends on their structure and resources. There are two main ways that community seedbanks can work with genebanks. The first is that genebanks can reintroduce varieties to then be multiplied and stored in community seedbanks. The second is that community seedbanks will identify cultivars on farmers' fields, and then send them to genebanks for long-term conservation. The role of marginalized farmers and the benefits of the collections can be very high when a community leads them and when they do not maintain forms of marginalization which might be present in that certain community. Additionally, they must also have sufficient resources to maintain viable material. During the interviews, experts said that the community seedbanks in Zimbabwe, Kenya, Uganda, Nigeria, Ethiopia, Nepal, and China work well and conserve a great deal of relevant material for marginalized groups. To facilitate distribution, for example, the community seedbanks in Kenya created farmer-to-farmer seed exchange platforms where farmers can buy seeds form colleagues with mobile money.

Based on the interview results and literature research we summarized the following lessons-learnt on how to strengthen the role of marginalized groups in *ex situ* conservation, and also more generally the role of smallholder farmers (see section 4.2):

- Establish good and trustful relationships between genebanks and marginalized groups.
- Show and promote the usefulness of *ex situ* conservation.
- Support farmers in testing and examining material collected *ex situ*.
- Maintain and scale up the interdisciplinary and integrative approach of participatory plant breeding.
- Promote the benefit of the overall community when targeting a specific marginalized group.
- Use inclusive language and be aware of social and gender dynamics when designing and implementing projects.
- Recognize Indigenous and traditional knowledge.
- Engage youth in PGRFA use and conservation efforts.

Following the research, the following recommendations for strengthening the role of marginalized groups in *ex situ* conservation can be drawn (see section 4.3):

- Create an inclusive, and farmer-led system of PGRFA conservation, exchange, and use.
- Discuss within the global system of *ex situ* conservation how to include and reach marginalized groups.
- Prioritize the conservation and characterization of PGRFA for marginalized groups and close the gaps in conservation of orphan crops and CWR.
- Characterize the complete accessions of genebanks, use and improve genebank information systems, and make the data publicly available.
- Implement and test options to collaborate with marginalized groups.
- Promote the purpose and existence of *ex situ* conservation.
- Expand the roles and mandates of institutions of *ex situ* conservation.
- Connect institutions of *ex situ* conservation with social science and gender experts.
- Diversify genebank staff.
- Separate women and youth when considering the focus group of a project and identify their needs separately.
- Support community seedbanks in being multifunctional and better embedded in the *ex situ* conservation network.
- Designate more support and funding for institutions of *ex situ* conservation.

This study investigates how genebanks interact with marginalized groups, how strong the roles of marginalized groups are with respect to *ex situ* conservation, and how these roles can be strengthened. In summary, there was no explicit strategy regarding who is marginalized and how to include marginalized groups by institutions of *ex situ* conservation. Rather, *ex situ* conservation institutes implemented various inclusion activities, directly or indirectly working with marginalized groups, that ranged from redistribution programs, attending requests, PPB, collaboration with community seedbanks, targeted conservation of orphan crops and retrieval and distribution of accession-level data among other methods. This, again, highlights how varied inclusion can be given various contexts.

This study was conducted to the best of the author's knowledge and ability. Due to time and funding limitations, not all *ex situ* conservation institutions could be interviewed. Additionally, some of the people invited for interviews did not respond. In total, 53 people representing institutions of *ex situ* conservation and also experts on gender or social sciences, PGRFA use and conservation as well as the international legal framework, were invited. The response rate was 56 %. Overall, most interviewees regarding community seedbanks were from African countries. Experts and information availability most suggested these and hence the representation of Asian and Latin American experts is lower in this study.

Smallholder farmers and marginalized groups are important custodians and users of PGRFA. Therefore, they can benefit from material and data stored *ex situ* and support genebanks in growing their collections. This dynamic creates a win-win situation when institutions of *ex situ* conservation work directly or indirectly with marginalized groups. Furthermore, this exchange of material and data is vital for conserving agrobiodiversity and improving global food security.

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# 7. Annex

## Institutions and system of PGRFA conservation

The following are brief definitions and descriptions of institutions, systems and approaches that conserve and govern PGRFA conservation, to clearly differentiate between the topics in our further discussion, as they are repeated throughout.

**Genebank definition**

Genebanks collect and store genetic resources to ensure the conservation and availability of diversity for food security (Diez et al. 2018). Germplasms that can be stored in genebanks include seeds, pollen, spores, semen, eggs, embryos, cells, and tissues (Zegreye 2017).

**Community seedbank definition**

A community seedbank is defined as a locally governed and managed institution whose core function is to maintain seeds for local use (Song et al. 2021). Community seedbanks are forms of collective community action to withstand and counter crop diversity loss, through the collection, storage, and management of seed that can be accessed by the local communities (Vernooy et al. 2020b). Community seedbanks exist throughout the world as vehicles to address crop shortages, conserve biodiversity, and to grow the existing seed system in a particular community or region.

***Ex situ* and *in situ* conservation**

*Ex situ* conservation is the conservation and storage of components of biological diversity outside of their natural habitats (for example, in a gene- or seedbank). It includes seed storage, field genebanks, in vitro storage, and botanical gardens and arboreta (Engels and Maggioni 2008).

*In situ* conservation is the conservation of species in their natural habitat, or in the case of cultivated species, in the environment where they have developed their distinctive processes. *In situ* conservation allows for species to maintain dynamic relationships with their own habitat, allowing for gene flow, geographical distribution, and evolutionary processes to take place. Ultimately, however, *in situ* conservation cannot take place in environments with high pressures, from human or climate affecters, whereas *ex situ* conservation exists outside the natural environments (Zegreye 2017).

**Complementarity of *ex situ* and *in situ* conservation**

The need to integrate the two approaches has been recognized in science for decades (Dulloo et al. 1998), with FAO formally recognizing it in 1996 (Engels 1996). Due to the nature of both approaches, they can be highly complementary to one another. *Ex situ* collections must be regenerated, to maintain material viability, however this process is costly and time-consuming (Dulloo et al. 1998). Furthermore, not all agrobiodiversity can be stored *ex situ* (Engels and Ebert 2021). Living (*in situ*) collections can experience genetic drift and mutations, which increase diversity, but alter the conserved material. Therefore, *in situ* collections require a backup by *ex situ* conservation (Zegreye 2017). The latter can in turn benefit from *in situ* conservation when altered material is newly integrated in *ex situ* collections. Complementary projects might also find material on farmers' fields which has not been stored yet *ex situ*. Furthermore, by combining both approaches, knowledge attached to the material can be transferred from farmers' fields to genebanks and their data banks and hence enrich the overall knowledge on a particular accession. The conservation of crop wild relatives (CWR) is a strong example of the necessity in applying both an *ex situ* and an *in situ* approach, as CWR are able to develop their unique traits and genetic diversity in their natural wild environments, it is important to preserve those environments so that the CWR may do so (Castañeda-Álvarez et al. 2016).

There is also a great deal of positive potential in breeding through the utilization of combined *ex situ* and *in situ* conservation, even though the idea is contentious in the food security research community. This contention comes more from the fact that complementary *ex situ* and *in situ* farming has not widely been formally researched and requires a large amount of funding and attention to monitor the process (Kasso and Balakrishnan 2013). However, the adaptive improvements that natural selection provides for are crucial, and combining the natural processes of environmental adaptation over time with scientific genetic breeding allow for specifically targeted trait breeding and new crop variation in adaptable environments (Cortes and Lopez-Hernandes 2021).

**The global system of *ex situ* conservation**

This is the worldwide community of genebanks and institutions that work both together and individually to conserve and use PGRFA, as well as the policies and global action plans that regulate and support their work (Crop Trust et al. 2020). Within the global system, CGIAR genebanks are a central pillar, due to their global mandates, the size and diversity of their collections, and the international partnerships they maintain (Crop Trust et al. 2020). Article 15 of the ITPGRFA describes their objectives and tasks regarding *ex situ* collections. Against the backdrop of the ITPGRFA and considering the vast number of different actors in *ex situ* conservation, as well as the prevalence of *in situ* conservation for farmers, the need to facilitate and consistently re-evaluate a global system is a key discussion point in designing the future of *ex situ* conservation that provides equitable access and support to all stakeholders, including farmers in the Global South (Hamilton 2020).

## Annotated directory of genebanks, programs, projects and organizations working on inclusive breeding, conservation, and use

The following table presents an annotated directory of genebanks, programs, projects and organizations working on breeding, conservation, and use which include marginalized groups (with a focus on women, youth and Indigenous groups). This includes gender-responsive breeding, conservation, and use. When available, key contacts are given and the activities are described with respect to their contribution to aspects of gender, youth, and Indigenous or ethics groups. Further, the last column explains if the mentioned genebank, program, project or organization includes dynamic or complementary conservation, which combines *in situ* and *ex situ* conservation. This directory is a result of the literature and desk research as well as the expert interviews conducted. Therefore, genebanks, programs, projects, or organizations on which no information was published or received are not included.

*Table 3: Annotated directory of genebanks, programs, projects and organizations working on inclusive breeding, conservation, and use.*

| **Genebank, program, project, or organizations with key contacts** | **Activities regarding breeding, conservation, and use with a focus on** | | | |
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| | **Women/gender** | **Youth** | **Indigenous groups or ethnic groups** | **Dynamic or complementary conservation, combining *in* and *ex situ*** |
| ABC and ICARDA:<br>Seeds for needs (multiple countries)<br><br>Contact:<br>Carlo Fadda c.fadda@cgiar.org | No strong focus on women, as the main goal is to adopt crop diversity to climate change. | No information found (-) | Focus on rural poor. | No explicit *ex situ* conservation, focus on farmer-preferred breeding and diversification. |
| ABC:<br>Bridging agriculture and environment: Southern African crop wild relative regional network<br><br>Contact:<br>Ehsan Dullo: e.dulloo@cgiar.org | Gender-conscious conservation, increased access to germplasm. | - | - | Establishment of genetic reserves for *in situ* conservation of CWR (crop wild relatives), no connection of both conservation approaches. |

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| ABC:<br>The Pan-Africa Bean Research Alliance (PABRA)<br><br>Contact:<br>ciatkenyainfo@cgiar.org | Has gender aspect to program, collaborative multi-faceted partnerships to improve beans, using market-led approach for breeding, access to technologies. | - | - | - |
| Biodiversity:<br>Establishing a community seed bank handbook. Limpopo, South Africa<br><br>Contact:<br>Ronny Vernooy<br>r.vernooy@cgiar.org | Women farmers preserve and restore seeds and crop varieties. | - | - | Seeds are stored *in situ* and *ex situ*. |
| CIMMYT genebank:<br>Rematriation of maize landraces to Indigenous smallholder farmers<br>(see Ocampo-Giraldo et al. (2020) for more information).<br><br>Contact:<br>Bram Govaerts<br>Cimmyt-dgoffice@cgiar.org | - | - | Indigenous communities are involved. | The activities connect *in situ* and *ex situ* conservation. |
| CIP genebank:<br>Repatriation program of the International Potato Center (CIP), redistribution of potato landraces to Andean smallholder farmers (see Lüttringhaus et al. (2021) for a description of the program). | - | - | Primarily the project is targeted towards Andean, potato-centered smallholder farmers. In Peru these are not termed Indigenous, | The activities connect *in situ* and *ex situ* conservation. |

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| Contact:<br>Gomez, Rene (CIP)<br>R.gomez@cgiar.org<br>Manrique, Norma (CIP)<br>N.Manrique@cgiar.org | | | as this term is rather used for ethnic groups in the Amazon region. | |
| CIP:<br>Gender-differentiated trait preference for sweetpotato varieties in Mozambique - Focus group study<br><br>Contact:<br>Chalmers K. Mulwa:<br>C.Mulwa@cgiar.org | Gender-responsive breeding with a focus on women trait preferences, shows potential for the integration of gender-responsive ex-situ conservation efforts. | - | - | - |
| CIP:<br>Gender-responsive participatory varietal selection for sustainable seed potato systems in Assam, India<br><br>Contact:<br>Nozomi Kawarazuka<br>n.kawarazuka@cgiar.org | Gender-responsive breeding regarding trait preferences, focus on women, participatory varietal selection (flowering and harvesting stages), women’s active participation. | - | - | - |
| ICARDA:<br>Scaling Up Initiative + Mind the Gap Tunisia<br><br>Contact:<br>Udo Rudiger<br>U.Rudiger@cgiar.org | Training program empowering women to pursue sustainable farming, knowledge sharing, credit sharing, technical training. Project | But potential for youth engagement as so far youth and women are grouped | - | - |

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| | also improves seed delivery. | together as a focus group. | | |
| ICARDA:<br>Gender-responsive extension Program: Tunisia<br><br>Contact:<br>Dina Najjar<br>D.Najjar@cgiar.org | Gender-responsive digital extension to narrow information gap for women, increase adoption of technologies, improve women's decision making | - | - | - |
| ICRISAT:<br>PGRFA conservation workshop in Chad (completed project)<br><br>Contact:<br>Falalou Hamidou<br>f.hamidou@cgiar.org | - | Mentioned on the website generally in goals to engage more youth. | - | Repatriation of landraces enables *ex situ* and *in situ* conservation, participants included national genebank manager, farmers, breeders, research technicians, agricultural agents. |
| ICRISAT:<br>CGIAR Gender and Breeding Initiative (GBI)<br><br>Contact:<br>Holly Holmes<br>h.holmes@cgiar.org | Analysis and incorporation of gender perspectives from the start of the breeding program. Explicitly addresses gendered needs. | - | - | - |
| IITA:<br>Youth Agripreneurs (IYA)<br><br>Contact:<br>agripreneur@cgiar.org | - | Incubation center where young graduates are trained in agribusiness. | - | This is more geared towards agricultural development through youth empowerment, with potential for genebank integration |

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| | | | | with *ex situ* and *in situ* conservation and youth engagement. |
| IITA:<br>Gender study maize shelling and technology<br><br>Contact:<br>Gundula Fischer<br>g.fischer@cgiar.org | Gendered differences in access to technology and machinery, non-inclusive data collection and outreach. | - | - | - |
| ILRI:<br>Gender Planning in Livestock project<br><br>Contact:<br>Alessandra Galiè<br>a.galie@cgiar.org | Developing research methodologies to better include women in the development of technologies, practices, and approaches. | - | - | This general project could be adapted to conservation of PGRFA efforts as well. |
| ILRI:<br>Feminization of Agriculture (completed project)<br><br>Contact:<br>Alessandra Galiè<br>a.galie@cgiar.org | Explored the gender-dynamics at the intra-household and community levels that influence gender roles in agriculture. | - | - | The methodologies and learnings accrued from this project could be applied to CGIAR research in the future. |
| IRRI:<br>Assessing Institutional Innovations to Promote Women-Led Informal Seed Systems in Eastern India (completed) | Researched the different means and extents to which partners engaged women and communities in this initiative and introducing stress-tolerant rice | In the project's annual report 2019, under social equity is the goal: 'create opportunities for youth'. | Recognized that women have indigenous know-how in the context of this project and were valuable in the seed systems. | - |

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| Contact:<br>Swati Nayak s.nayak@irri.org | varieties into the regions, women producers were very effective. | | | |
| IRRI:<br>Scaling gender-sensitive climate-smart villages in southeast Asia<br><br>Contact:<br>Julian Gonsalves juliangonsalves@yahoo.com | Develop effective scaling strategics of emerging climate-smart agriculture (CSA), increase uptake of CSA practices by agricultural communities, focus on gender and youth. | Focus on gender and youth. | - | - |
| IRRI:<br>Closing the gap: Women-focused initiative empowers farmers in Odisha (completed)<br><br>Contact:<br>Ranjitha Puskur r.puskur@irri.org | Women producer company led by women, provides services such as input provision for seeds, fertilizers, bio-pesticides. machinery, financial services | - | - | Approach could be integrated to PGRFA conservation initiatives. |
| World Agroforestry:<br>Gender-responsive innovations for soil rehabilitation, alternative fuel, and agriculture for resilient refugee and host community settlements in East Africa<br><br>Contact:<br>Clement Okia c.okia@cgiar.org | Increased gender-responsive energy and food security, more developed gender-responsive circular economy solutions | - | Focus among refugee and host communities, sustainable socio-ecological systems (east Africa sub-region hosts 3.2 million refugees and 5.7 million internally displaced persons). | - |
| UBINIG Specialized Women's Seed Network Bangladesh | - | - | Local Indigenous communities. | Complementary in situ and ex situ conservation trainings |

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| Contact:<br>ubinig@citechco.net | | | | by women for women. Activities: Ex situ conservation and seed hut operations. |
| Nayakrishi Network of community seedbanks Bangladesh<br><br>Contact:<br>nkrishi@bracbd.net | Women empowerment | - | Local Indigenous communities. | Complementary in situ and ex situ conservation, knowledge sharing. Ex situ conservation and seed hut operations, community seedbanks. |
| Seed Grower Associations India Community seedbanks<br><br>Contact:<br>NA<br>For more information see Vernooy et al. (2022). | 50 % of participants are women. | - | - | Focus on ex situ conservation. |
| Gumbu Limpopo community seedbank program<br><br>Contact:<br>NA<br>For more information see Puskur et al. (2021). | Focus on gender-responsive breeding and providing women with more access to seedbanks, traits, and economic autonomy. Women as key actors, additional extra cash programs through involvement, gender-responsive breeding. | - | - | Focus on ex situ conservation. |

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| Tuk-tuk mobile seed shops Uganda<br>Victoria Seeds Project<br><br>Contact:<br>info@victoriaseeds.com | - | - | Goal to bring seeds to more remote villages via local transport. | - |
| Community genebank island of Maluku in Nepal<br><br>Contact:<br>NA<br>For more information see Leunufna et al. (2014). | - | Focus on engaging youth. | - | Complementary of in situ and ex situ conservation. |
| Alea labor sharing program northeastern Uganda<br><br>Contact:<br>NA<br>For more information see Puskur et al. (2021). | Gender responsive breeding, focus on women's preferred traits. | - | - | Community women conserving ex situ and in situ. |
| Diversity fairs in Nepal<br><br>Contact:<br>NA<br>For more information see Vernooy et al. (2015). | - | - | Focus on indigenous landraces, promoted locally. | |
| PPB Maize in south-west China<br><br>Contact:<br>NA<br>For more information see Song et al. (2021). | - | - | - | Genebank and breeding between farmers and scientists. |

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| Seed Savers Network Kenya<br><br>Contact:<br>Daniel Wanjama<br>seedsaversk@gmail.com | Farmer seed sharing/saving networking and trainings, with focus on women as seed custodians. | - | - | Complementary focus on community seedbank ex situ conservation and in situ farming methods/trainings. |
| Māori Biosecurity Network<br><br>Contact:<br>Melanie Mark-Shadbolt<br>mel@ttw.nz | - | - | Focus on Indigenous knowledge, delivers seed to Indigenous areas. | Community conservation, in situ and ex situ. |
| Crop Trust:<br>Crop Wild Relatives Project<br><br>Contact:<br>cropwildrelatives@croptrust.org | Collects important species of crop wild relatives, ensures long-term conservation, facilitates their use in breeding new, improved crops- nothing explicit about gender however other news showcases attention to gender-responsive breeding. | - | - | - |