

## Article

# Farmer-Led Seed Production: Community Seed Banks Enter the National Seed Market

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**Abstract:** Smallholder farmers around the world obtain their seed from various sources, which can vary over time. In some countries, smallholder farmers are gaining ground as local seed producers and sellers. This study focuses on the seed production and marketing operations, achievements, and challenges of a particular type of such producers—community seed banks—which are new players in the seed market. Pioneer case studies are presented from countries where grain legumes and dryland cereals are important crops: India, Nepal, Uganda, and Zimbabwe. A mixed methodology was used to collect data, including a literature review, focus group discussion, key informant interview, and participatory observation. The case studies demonstrate the viability of community seed banks as seed businesses but becoming successful is not easy and depends on managerial, technical, financial, social, and policy factors. The cases benefitted from strong initial support provided by a committed and experienced organization, as part of a trajectory of nurtured seed development and empowerment. Embedding local seed enterprises in seed sector networks is crucial to creating demand and gaining recognition and support. Government and development organizations could learn from the case study experiences and support programs to foster local seed businesses as key actors in integrated seed sector development.

**Keywords:** community seed bank; dryland cereals; grain legumes; integrated seed sector development; local seed business



**Citation:** Vernooy, R.; Rana, J.; Otieno, G.; Mbozi, H.; Shrestha, P. Farmer-Led Seed Production: Community Seed Banks Enter the National Seed Market. *Seeds* **2022**, *1*, 164–180. <https://doi.org/10.3390/seeds1030015>

Academic Editor: Ulrike Lohwasser

Received: 16 March 2022

Accepted: 28 June 2022

Published: 4 July 2022

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## 1. Introduction

In many countries around the world, farmers obtain seeds from a diversity of seed production sources—these can be based locally (e.g., neighbors, relatives, friends), regionally (e.g., a seed cooperative or association), nationally (a national extension agency or national seed company) or internationally (a multinational seed company or an international genebank). In any given year, a farming household might use their own saved seed for crops such as bean (*Phaseolus vulgaris*), finger millet (*Eleusine coracana*), (traditional) maize varieties (*Zea mays*), rice (*Oryza sativa*), and sorghum (*Sorghum bicolor*). The household may buy groundnut seed (*Arachis hypogaea*) at the local market and seed of exotic vegetables from national or international commercial companies. In some countries, the household may obtain seed of improved or hybrid maize from national public research institutions through government extension services or international aid distribution programs, e.g., in countries affected by conflicts and/or natural disasters [1]. The following year, the

household might decide to change the mix of crops and their seed sources, adapt to new circumstances, or explore new (business, market) opportunities [2].

Mechanisms to obtain seed and planting materials (e.g., seedlings, suckers) vary and include monetary and non-monetary transactions (e.g., seed exchanged for “future” seed yet to be harvested, seed exchanged for a fixed number of labor days, seed to be paid for with a fixed percentage of the expected harvest). Frequently, seed transactions are embedded in the fabric of cultural, ethnic, religious, and socioeconomic relationships in the community and beyond. Thus, seed are both planting material, i.e., physical capital, and social capital. For example, farmers use seed as gifts to establish (new) or solidify (existing) social relations with benefits expected at a later moment in time. Women farmers play key roles in farmer seed systems, often as the principal seed custodians, although they are often overlooked by researchers, development personnel, policies, and programs. Social actors engaged in producing and distributing seed in most countries include:

- Individual seed-saving farming households,
- Farmer seed networks (usually informal; sometimes, more structured and supported by a non-government organization),
- Community-based seed producers (e.g., a community seed bank with a seed production arm),
- Local traders (who sell grain and seed),
- Local seed enterprises catering to local markets in low volumes,
- Government seed operations or programs,
- National private seed companies,
- Regional and multinational private seed companies.

Many factors influence the operations of seed producers and distributors, whether or not these operations are integrated into a single enterprise or organization. They include history, objectives, types of crops and crop variety, types and levels of investment (science and technology, capital, human resources), scale, size, type, and density of seed networks, use, and type of intellectual property rights, and the policy and legal context [3]. Policies and laws regulate who can produce and sell which kind of seed, how quality assurance is organized, and how rewards and support are allocated. Regulatory frameworks vary among different countries, though efforts are underway to make them more harmonized, for example, in different regions of Africa. The frameworks usually have a significant influence on how the seed sector evolves, how power and influence are distributed, and in which direction the sector moves [2]. Besides the socioeconomic and political factors, environmental factors are also important, including climate change.

The focus of this paper is farmer-produced seed, given that a large part of the seed that is produced and distributed by the commercial system is too expensive or not easily accessible and is often not suited to the particular local environment of most farmers, in particular of smallholder farmers in the global south [4]. Farmer-managed seed systems have the advantage of being responsive to local needs and preferences while contributing to the maintenance of crop diversity on the farm and in local communities [5–8]. This is essential for seed and food security. The importance of farmer-managed seed systems is evident from field data. For example, estimates for West Africa indicate that farmers access 90–98% of their seed needs from farmer seed systems [9]; for the rest of Africa, this figure is 70–95% [10]. In Zimbabwe, despite the presence of many commercial seed companies, it is estimated that 80% of seed needs are satisfied by smallholder farmer seed systems. However, there are challenges and bottlenecks, such as technical seed-processing requirements, time, and effort to develop entrepreneurial expertise, distribution, and marketing constraints, and policy and legal restrictions [11].

This paper presents a number of community (smallholder) seed producers, in particular community seed banks, while recognizing that in recent years other farmer-driven forms of seed organizations have emerged, e.g., seed cooperatives (such as in West Africa) [9]. Community seed banks first emerged with a focus on the conservation of crop diversity, but in recent years, some have developed additional and complementary activities, such as

crop improvement and seed production and distribution [12,13]. Community seed banks are usually managed by a small group of dedicated seed custodians, who, often receive (initial) technical, organizational, and financial support from an international, national, or local organization, although, in recent years, national governments (e.g., through the national genebanks or national plant genetic resources center) have started to establish and support community seed banks as part of the process of integrating ex situ and in situ conservation. Examples of the latter include Bhutan, Mexico, Nepal, South Africa, Uganda, and Zimbabwe. Most community seed banks conserve the seed of traditional/local varieties while some also include improved varieties, e.g., varieties developed through participatory plant breeding. Start-up collections are usually small (a few varieties of the main crops), but over time, as the managers and members of the community seed bank acquire more knowledge and skills, collections can grow to hundreds of “accessions”. Some community seed banks evolve into (rural) community development organizations, with a strong empowerment function, promoting local seed and food sovereignty, and offering rural services, such as the provision of affordably priced credit. Emerging experiences suggest that community seed banks can deal with some of the major bottlenecks that many seed systems are facing [14]. Common challenges faced by community seed banks are diverse in nature: technical (e.g., limited knowledge and skills with regard to conservation), organizational (e.g., poor leadership, the time needed to learn about new responsibilities and tasks, weak links with other seed sector actors), and economic (lack of income-generating opportunities). These problems are common to the practice of ex situ conservation [15] but carry likely more weight in the case of community seed banks given that they are managed by non-trained/non-professional conservationists. When these problems occur together, the sustainability of operations is affected or even threatened [16,17].

Although this paper focuses on community seed banks that maintain a conservation function, it is recognized that the concept of community seed banks is also used for community organizations whose only function is to produce seed, such as the model developed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Malawi, and later transferred to other countries [18]. Adding seed production and marketing to conservation is a novel pathway for community seed banks, with new opportunities and challenges, but it appears to have good prospects. Until now, no studies have focused on this activity and on the contributions of community seed banks to integrated seed sector development [19]; this article aims to fill this knowledge gap by presenting a synthesis of the findings of a four-country study [20].

### COVID-19

Unexpected major events, such as the COVID-19 pandemic, put additional stress on farmers’ seed systems, affecting timely, affordable, and easy access to and supply of seeds of preferred varieties in the short and medium terms. In the spring of 2020, a team led by The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) developed a seed survey to assess the impact of COVID-19 on access to and supply of seeds in selected countries in Africa, Asia, and Latin America, oriented to farmers, community seed bank managers, and farmer seed entrepreneurs. Results from Kenya, Tanzania, and Uganda indicate that many farmers in these three countries experienced increases in the cost of seed and other inputs, including labor, and an increase in food prices. Farmers reported that it was harder to obtain seed, contract farm workers, and sell produce. Many farmers adjusted their cropping portfolio for the 2020 season. Results from a number of national seed sector assessments in 2020 by the Wageningen Centre for Development Innovation of Wageningen University and Research provide additional insights into the impact of COVID-19 [21]. To varying degrees, countries experienced some of the following effects:

- Mobility restrictions and social distancing measures hampered access to labor and agricultural inputs for seed production; transportation of seed from seed producers and companies to agro-dealers and points of sale; access to markets for seed companies,

- agro-dealers, and farmers, and the organization of a variety demonstrations and field days;
- Reduced availability and increased seed prices resulted in substandard seed appearing in markets;
  - Mobility restrictions limited field inspection services for quality seed assurance and the production and supply of early generation seed;
  - Constraints in the production, transportation, and marketing of seed increased seed prices;
  - Seed dealers disrupted markets by stockpiling seed and creating shortages to increase prices;
  - Government and other stakeholders crucial to seed sector regulation were hampered in convening, decision-making, and ensuring the implementation of regulations relevant to seed quality assurance, variety release, and seed imports;
  - It is important to understand if and in what ways community seed banks are able to deal with these bottlenecks by relying on the collective resources of their members.

## 2. Materials and Methods

This article is based on a number of pioneering community seed bank case studies from countries where grain legumes and dryland cereals are important crops. The case studies were composed through a mixed methodology in the tradition of studies carried out in the fields of anthropology and rural development sociology [22], using literature review (community seed banks, local seed businesses, integrated seed sector development), focus group discussion (with key actors of the community seed banks and local seed business development), key informant interview (with local leaders, technical staff), and participatory observation (field visits to seed plots and seed production facilities) [20]. Case study countries are India, Nepal, Uganda, and Zimbabwe, which are pioneers in the development of community seed banks [16,23]. The methodology follows the logic of the case studies of community seed banks developed by Vernooy et al. [12], which focuses on the origins, evolution, and prospects of community seed banks and addresses technical, organizational, financial, and institutional aspects. These aspects are enriched by insights from selected literature on farmer seed production and distribution. Key elements include the motivation for the establishment of a seed business (Who? Why?), the changes over time (What? Why?), the design and monitoring of a business plan, seed sourcing (Where? How?), inputs required for all the operations (What? Costs?), training and support needs and activities (What? Who? How?), roles of women and men, collaboration and networking (What? With whom?), policy and legal context, results and challenges, and prospects for the future.

The core conceptual framework for the documentation and qualitative review of the case studies includes the following key factors considered to be the drivers of the success of local seed business development [4,8,14,24]. Together, these factors represent a comprehensive framework:

- Sustained demand for quality seed, fueled by high demand for farmer produce, and/or support for farmer and community-based seed development;
- Availability of improved varieties from public sector breeding programs;
- Technical skills (seed production, conditioning, quality control, and certification), entrepreneurship (planning, management, monitoring, networking, accounting), and institutional capacities (design, review, implementation, and monitoring of policies and laws);
- Ownership and recognition of the roles of women and profitability;
- Connections with the formal seed, seed conservation, and plant breeding sectors;
- Access to affordable support services, e.g., extension, credit;
- Effective communications, appealing branding, and agile marketing;
- Conducive agricultural and seed policy environment that is supportive of the nature and scale of the seed enterprise envisaged. This includes the recognition of the farmers'

privilege (the right to save, exchange, and sell seed, even of commercial varieties) for farmer-based seed enterprises [25], support for privatization and commercialization of agricultural services, and also the recognition of plant breeders' rights.

### 3. Results

#### 3.1. Case Studies

This section presents four case studies of community seed banks that have succeeded in entering into seed production and marketing through a number of pathways, with operations of different magnitude and emerging results of various types. The cases are from India, Nepal, Uganda, and Zimbabwe, where Bioversity International (now the Alliance of Bioversity International and CIAT) and research and development partners have been engaged in community seed banking for many years, expanding the conservation efforts of community seed banks to include value addition activities.

##### 3.1.1. Community Seed Bank, Mandla, Madhya Pradesh, India

The policy environment in India is supportive of farmer seed initiatives. The seed exchanges facilitated by community seed banks are regulated, to a large extent, by the Seeds Act of 1966, which allows the free flow of seeds without a brand name among farmers through both non-commercial and commercial transactions. This means that, in practice, most community seed bank operations are legal. However, there is limited potential to enter the formal seed market as the free flow rule does not apply to branded seeds. To sell seed, seed banks must obtain a different legal status, e.g., cooperative. India is among the foremost countries in the world in terms of farmers' rights legislation with its Protection of Plant Varieties and Farmers' Rights Act of 2001 (PPVFR). Sections 24, 26, and 35 of the PPVFR describe various aspects of benefit-sharing. Farmers managing community seed banks receive mainly non-monetary benefits, such as capacity development and technology transfer. The law aims to protect the rights of both breeders and farmers. It not only supports farmers' privileges to save, use, and exchange protected seed and propagating material, but also strives to allow farmers to claim some unique forms of intellectual property rights over their varieties [26]. Nine farmers' rights have been included in the act: the rights to save, exchange, sell (non-branded) seed and propagating material; to register varieties; to be recognized and rewarded for conservation of varieties; to take part in benefit-sharing; to access information about the expected performance of a variety; to receive compensation for the failure of a variety to perform; to receive free services for registration and conducting tests on varieties; to make legal claims under the act; to be protected from innocent infringement.

Action for Social Advancement (ASA) is a non-profit development organization. It was founded in 1996 by a group of development professionals with considerable collective experience in working with tribal people in the central part of India on participatory natural resource development, in particular in Madhya Pradesh, Chhattisgarh, Bihar, and Jharkhand. Emphasis is placed on involving and working with the poor and women. ASA established its first community seed bank in 2013. The major activities of the community seed bank are seed production and conservation, value addition of millets, pulses, and rice, and input supply and marketing. Seed production of major varieties, such as Jeera Shankar, MTU-1010, IR64, JR-81, JRB-1, JK-439, JK-41, JK-137, DPS-9, INDRA-1, JK-36, and JK-38 started in 2014. There are 3380 active members linked to the community seed bank, comprising 1700 men and 1680 women, 302 and 260 of whom, respectively, are involved in seed production. It is likely one of the largest community seed bank seed producers in the country, and, likely, globally.

Availability of and access to good quality seed was an issue in farming communities primarily comprised of smallholder and marginal tribal farmers. With this in mind, the Farmer Producer Company (FPO), set up with the support of ASA and under the umbrella of the community seed bank, decided to undertake a seed production program. Currently, the FPO is involved in the production of seeds of minor millets, rice, wheat,

and gram. Every year, a separate business plan is developed for the FPO. The business plan is comprehensive and takes into consideration different components of inputs, seed production, and commodity trading. The development of the business plan involves the board of directors, some members of the FPO, staff of the FPO, and key members of ASA. The shareholders of the FPO are women and they play major roles in seed production; during village meetings, farmers are selected for the seed production program. Quality control of the seed production program follows strict seed production protocols. The ASA team, in collaboration with state departments, monitors the seed production plots through their inspectors and by involving farmers. Farmers receive a Seed Certification Tag after harvesting, grading, and clearance of seed samples. The FPO has its own registered brand, named “Dharti Naturals,” for the sale of FPO produce. This brand name is registered with ASA. Different FPOs use and contribute to it for promotion and communication. This brand is common and well known among the FPOs and in surrounding areas.

Every business pillar of the FPO has to be self-sustaining and should earn a profit. Based on this principle, seed production, purchase of inputs, and trading are considered cost centers, and, accordingly, cost is estimated per center and certain profits are anticipated. This helps in financial planning and ensures a positive cash flow. As a long-term strategy, a five-year rolling strategic plan is developed. Based on this plan, the annual business plan is prepared. The community-based seed enterprise is member-oriented, based on the understanding that it is also a social enterprise. The goal is to generate benefits for at least 80% of its members. With these basic criteria, the business strategy is defined. To ensure sustainability, a portion of the profit is kept separately for the marketing and promotion of the seed business. Usually, this is 5–8% of total turnover. The FPO buys back seed from the farmers and brings these onto the trade market with their own brand. In addition to market sales, the FPO also supplies seed to the Department of Agriculture of the state to meet its seed requirements. A database is maintained to identify product-related issues and necessary changes are made accordingly at product and service levels. However, the use of Information and Communication Technology (ICT) tools is limited.

For improved varieties, breeder seed is sourced from public agriculture institutions. The FPO has experience in the production of foundation and certified seeds. Seed growers have been able to maintain the purity of different varieties for use in seed production. Their shareholding model includes smallholder and marginal farmers, who use their own land for seed production. The FPO has 0.65 acres of land where they have constructed a warehouse and installed processing units for value addition of their produce. Farmers produce seed using family labor as per technical guidance of ASA and state agriculture departments. Over time, FPO has acquired various machinery for processing and value addition, such as a grader, de-stoner, de-husker, and final processing equipment for value addition.

During the 2020–2021 seasons, ASA focused its activities on three promising local rice landraces, which were identified during the pilot phase. Their performance was excellent (as good as released varieties); the names are Kala Sariya, Baghmuch, and Badal phool. Seed of the three varieties was multiplied on 16 hectares of land, resulting in 240 quintals of seed (1 quintal = 100 kg), of which the FPO procured 200 quintals @ INR 1200/– per quintal (on average in 2021, USD 1 = INR 74). Farmers kept the rest for their own needs and for free distribution to fellow farmers. On the basis of farmer demand from core villages and periphery in the area of FPO, FPO organized seed production of two released rice varieties, Kranti and MTU1010, resulting in 640 quintals of certified seed. The FPO bought the seed at a fair price of INR 3500/– per quintal from farmers (seed growers); with a sales price of INR 3700/– per quintal in the next Kharif season. In addition, the FPO organized seed multiplication of Kodo and Kutki rice varieties on 8 hectares each, yielding 80 quintals. Most of this seed was sold by the farmers with the support of FPO @ INR 2000/– per quintal for Kodo and INR 4000/– per quintal for Kutki. The FPO kept some seed stock for distribution among other farmers. These activities demonstrated to the seed growers and other farmers in the communities the strength and (commercial) value of their landraces, which were in the process of becoming extinct from the area. The activities also served to

gain and strengthen marketing skills allowing the mainstreaming of local seed production by farmers themselves. The fair price paid by the FPO for the seed served as an important incentive for the farmers.

The COVID-19 pandemic hit India hard. Apart from a very high number of deaths, the outbreak forced millions of migrant workers to return to their hometowns and villages, where many could not find work. ASA supported some of these migrant workers through the supply of seed to produce their own food; it also collaborated with local authorities to set up a payment for soil conservation and water harvesting scheme for them. For the interactions and training of the seed growers, ASA, in collaboration with the local authorities and farmer organizations, developed an online communication channel. ASA worked together with health authorities to create awareness about the disease outbreak, produce and distribute face masks, visit households to identify infected persons, send them for treatment, and organize a vaccination campaign.

The FPOs have been able to increase their production by at least eight times to several thousand quintals. All seed is sold by the end of the season, contributing to economic profitability. All the members have greatly benefitted from quality seed, which has improved their productivity. They have paid less for seed compared to the market price and when the FPOs made a profit, this was shared with the members as a patronage bonus. The FPO has established a close connection with its members. The supply of quality seed has ensured that the farmers continue to buy seed. Similarly, the FPOs, as the custodians of breeders and foundation seed, have ensured that seed is conserved in a scientific manner, complementing appropriate propagation among member farmers.

Prospects in India are good. In the area, local line departments, the District Administration, and agricultural extension centers (known as Krishi Vigyan Kendra or KVK) have become active and are engaging with seed growers and other farmers. They are also actively scaling the efforts to other areas of the District. ASA is backing up these outscaling activities with technical know-how. So-called Champion farmers (experienced seed producers) are playing a key role in the process as well.

### 3.1.2. The Kiziba Community Seed Bank and the Joy and Family Demonstration Farm, Uganda

Uganda has an increasingly supportive policy environment for smallholder farmer seed initiatives. In 2021, the Plant Genetic Resources Centre (PGRC) of the National Agricultural Research Organisation (NARO) produced Standard Operational Procedures to guide the establishment of community seed banks in the country in harmony with national policies. PGRC, home to the national genebank, was also instrumental in the development of the Protocol for Collaboration between the National Genebank and Community Seed Banks, which was published in 2021 and endorsed by the PGRC. The PGRC coordinated a review of the process of developing the draft national policy for Plant Genetic Resources for Food and Agriculture (PGRFA), with due attention paid to farmers' seed systems, local seed businesses, and the roles of community seed banks. Uganda's national PGRFA policy, developed over the last 12 years, is still in its draft form. During this period, baseline information has been updated, several consultations with stakeholders were held, the document was drafted—including detailed activities, tasks, and budget—and a national validation workshop was convened. Currently, the draft is with the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), the responsible ministry, and awaits discussion and approval.

Uganda has adopted the quality-declared seed (QDS) system, which has minimum certification requirements for specific food crops (e.g., beans). QDS is a formally recognized seed class with a green tamper-proof label. The Integrated Seed Sector Development (ISSD) program works through zonal partners including agribusinesses and seed specialists. The beneficiaries who receive the QDS seed are business-oriented farmer groups, which are identified and transformed into local seed businesses (LSBs). To date, over 270 LSBs have been established. The QDS system is supported by MAAIF and the various district local

governments. QDS and LSBs are important elements of Uganda's revised national seed policy [27].

The Kiziba community seed bank was established in 2008 as a joint effort between local farmers and scientists who were promoting the use of bean diversity as a means of controlling pests and diseases. The local community provided the land and Bioversity International and NARO contributed by constructing the building that houses the seed bank. Before its establishment, the community that it serves maintained only 13 bean varieties. Through the efforts of the National Genebank of Uganda (under NARO), an additional 46 varieties have been introduced. The seed bank currently conserves 69 bean varieties and serves over 1000 farmers in 17 villages in Kiziba Parish and beyond. The seed bank was established with the aim of increasing the diversity of beans in the area, improving access to seeds, and conserving bean varieties that were on the verge of disappearance. Farmers selected a management committee of 10 members, one of whom was Joy Mugisha, who became the quality assurance manager of the Kiziba community seed bank. Farmers from four villages, Rubaare, Rwenkarabo, Ntungamo, and Nyamirimo, joined the initiative. Joy and the committee started bean trials in these four villages, assessing and collecting data each season on pests and diseases, such as bean fly, anthracnose, and angular leaf spot, and their effect on yield. Joy and her family were one of the host farmer households of these experiments. In 2013, the bean trials were complemented by banana trials and again, Joy and her family were selected as trial host farmers. They assessed and collected data on black sigatoka and banana weevils.

In 2014, the seed bank was registered as a community-based organization and started operating legally as a local organization to promote rural development more broadly. In the same year, farmers were trained by a technical team from the seed inspection services of MAAIF, in collaboration with Bioversity International, on the production and quality assurance of foundation seed. Forty-eight farmers expressed interest in growing the foundation seed of beans for the breeding program at the National Crops Resources Research Institute (NaCRRI), with the help of the ISSD Uganda program. As a result, in 2016, a cooperative society was registered for the purpose of seed production and marketing.

To effectively transfer practical skills to other farmers, use was made of demonstration gardens, which were managed by farmer groups—including members of the Kiziba community seed bank—and field days were organized to popularize the use of good quality seeds to improve productivity and food security within the communities. These gardens, where farmers could meet and exchange knowledge and ideas, were also used to compare the yield advantage of using good quality bean seed and to test novel agronomic practices to improve management. Bean yields in the districts of Bushenyi, Sheema, Ntungamo, Isingiro, and Mbarara, where demonstration gardens were introduced, increased by 20–24 times after two years of experimentation. On average, yields varied between 500 and 700 kg per acre, depending on the district and the rains received. Higher yields were a strong incentive for the farmers to continue their efforts.

For particular seasons, seed is sourced from the Mbarara Zonal Agricultural Research and Development Institute (MbaZARDI) or from NaCRRI-Namulonge, accessed by booking in advance. Through venturing into foundation seed production in collaboration with NaCCRI, farmers have access to greater diversity and also participate in the dissemination of new varieties and their testing. The Kiziba seed cooperative received QDS certification after meeting all requirements of the Seed Certification Services and started producing quality-declared seed of registered bean varieties, i.e., NABE 4, NARO bean 1, NARO bean 2, and NARO bean 3, for sale. The seed cooperative also started multiplying foundation seeds of the above-mentioned varieties for NaCCRI on a contractual basis.

The seed cooperative had the opportunity to interact and collaborate with other seed producers in the southwestern Uganda sub-region, under the Southwestern Seed Banks Association (SUSBA). For tenders and contracts that require greater quantities of seed than can be produced by a single seed bank, seed banks come together under SUSBA and pro-

duce under a single contractual agreement, hence taking advantage of economies of scale. The business plan is comprehensive and takes into consideration different components of seed production, such as production and field inspections (which they pay for) as well as quality assurance after harvesting. Business plan development and implementation involve a committee, which is comprised of a records manager, quality assurance manager, productions manager, and marketing manager who work collaboratively throughout the whole process of seed production and post-harvest handling, including packaging. The business of seed production is always farmer-funded due to the fact that each farmer plants depending on their capacity.

Marketing is mainly done through participation in different food fairs and by attending different market shows, where farmers showcase different bean seed varieties and attract buyers. Besides this, value addition is a very important aspect of seed production. Unpackaged seeds are sold for UGX 4000 per kilogram (about USD 1.10), but the seed cooperative sells packaged seed for UGX 6000 per kilogram. Kiziba's seed cooperative packages its seed and puts a green label on it, indicating QDS certification. Since 2017, bean seed varieties produced for sale include NARO bean 1, NARO bean 2, NARO bean 3, NABE 4, NABE 14, NABE 16, and NABE 19. Varieties produced have varied seasonally depending on the interest of subcontractors and which varieties are in highest demand. In the 2021/2022 season, despite the impact of the COVID-19 outbreak, the community seed bank increased its production to over 2000 kg of bean seed, half of which was produced for NaCRRI as foundation seed. The number of farmers' engaging in seed production also increased; in the 2021/22 season, there were an additional 23 farmers who joined the Kiziba seed cooperative as seed producers. They received several rounds of training on the production of quality-declared seeds (known as QDS).

Through this experience, the lead Kiziba farmers were able to become experts in seed production. They have started to train people from Kabale-Rubaya Seed Bank, Nakaseke and Nakasongola farmers, Hoima Community Seed Bank, and more recently, Nyando lower and upper farmers in Kisumu, Kenya, on how to produce quality seed with the support of the Dutch Non-Government Organization (NGO) Hivos, and with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

### 3.1.3. Agyauli Community Seed Enterprise, Nawalparasi, Nepal

Nepal has increasingly created policy space for farmer seed initiatives, first and foremost for the conservation of agrobiodiversity (through the agrobiodiversity policy), and for seed production and marketing. The National Seed Policy (1999) focuses on seven areas of the seed sector: variety development and maintenance, seed multiplication, quality control, increased involvement of the private sector, seed supply, institutional strengthening, and biotechnology. Its main objective is to provide a policy framework and guidelines to ensure the production and distribution of good quality seeds, promote the export of such seeds, make seed commerce effective in terms of existing world trade and conserve and protect rights over seeds of local crop varieties with distinctive genetic traits. Nepal allows for "Truthfully" labeling, which can be used by farmer producers and private companies without approval from the national seed certification authority, but quality standards for purity and germination need to be respected according to national rules and regulations. The government, in particular through the National Agricultural Research Council (NARC, under which the national genebank is housed), has been supportive of community seed banks by providing technical and more recently, financial support, although community seed banks have yet to obtain autonomous legal status.

The Agyauli Community Seed Bank was established in 2010 with the technical and financial support of the national NGO Local Initiatives for Biodiversity, Research and Development (LI-BIRD). The Agyauli community seed enterprise is one of several community seed bank-based seed enterprises in Nepal, many of which have been supported by LI-BIRD. It has become a well-managed community seed bank and is often presented as a

“good practice model” to emulate. The following factors have contributed to its success as a well-functioning community seed bank [28]:

- Committed leadership and a strong feeling of ownership by the community,
- Community seed bank members receive economic benefits from activities,
- Functional collaboration with public, private, and civil society organizations,
- Production of seeds at volume and a well-developed marketing approach,
- High level of external interaction and strong capacity-building support,
- Mechanism to sustain operations over the longer term.

In 2018, the community seed bank conserved 73 varieties of 25 crop species, of which rice is the most important, and 54 local varieties. The community seed bank is managed by the Agriculture Development and Conservation Farmers Committee (ADCFC), a group of committed farmers from the area. ADCFC activities began with 35 farmer members in 2008. At present, there are 953 farmer members. The committee was registered through the District Administration Office in 2014. Later, the municipality registered a parcel of land for the community seed bank and constructed a meeting room and storage room. In 2019, additional storage facilities were constructed for seed storage and sale. LI-BIRD supported ADCFC with an initial amount of NPR 250,000 (about USD 2500). This fund has now increased to NPR 900,000. ADCFC gives loans of up to NPR 30,000 to its members at a 12% interest rate. This money may be used only for agricultural activities. Farmers have used the loan to rear pigs and buffalos, and for banana cultivation.

Seed production and sale were first started by ADCFC in 2015 as a means to generate income for local farmers (members of the community seed bank) and support the operations of the Agyauli Community Seed Bank. In 2015, three rice varieties totaling 27 metric tons were marketed; 20 t had been planned. Production increased to 45 t in 2017 and in 2018 seven varieties were produced, though production dropped to 25 t. In 2019, eight varieties were produced. In 2018, 26 farmers were part of the seed enterprise. The drop in production in 2018 was due to irregular seed inspection by the technician in charge; part of the harvest could not be certified. In the group discussion, participants stressed the need for professional support from skilled people. When this support is not delivered, farmers suffer immediately. The increase in the number of varieties reflects both higher demand and a greater capacity to respond to this demand. Originally, common rice varieties were marketed based on the assumption that demand for these was the highest. However, local varieties, such as Jhinuwa, were introduced and tested on a small scale in farmers' fields. This variety is now in the process of becoming formally registered at the National Seed Board. This will allow Agyauli Community Seed Bank to produce and market its local variety seed in a branded form. A total of 50 t of seed was planned for 2021, but the unexpected heavy rainfall which occurred in the month of November, which is the rice seed harvesting time, damaged the seed plot. The community seed bank was able to produce only 17 t, of which 2 t of local varieties and 15 t of improved varieties.

The seed-producing farmers, largely women, received technical training from the then District Agriculture Development Office (DADO) (now the Agriculture Knowledge Center). The DADO and the Anamol Seed Company provide source seeds. Production plans are discussed at the Municipality Office with relevant officials. It is a real price based on actual production costs but is kept slightly below the market price to incentivize farmers to buy seeds locally. In 2020, they also collaborated with the municipality and sold seed on a 50% subsidy basis. The 50% price of the seed was paid by the municipality. They have also received a small tractor from the municipality. It is possible for a community seed bank to sell seed at a lower price compared to other sources because (i) they are service oriented; (ii) the physical infrastructure is built with external support; (iii) operational costs are low given that members are volunteers and only a few local staff are contracted. Seeds are produced through an informal agreement with member farmers; no contract is signed. The sales of seed are monitored and each year the seed management team assesses demand through a market survey. The major buyers of seed are Anamol Seed Company and three other seed entrepreneurs, complemented by about 150 farmer buyers every year.

So far, the seed business has been very successful and expansion of production to 100 t is planned. In 2016, total sales were worth about NPR 12,000,000 (USD 100,000). Finding a permanent local technician who can support the process technically and assist when problems arise has proved a major challenge. One promising crop other than rice is cowpea, for which one of the seed enterprises has a high demand. In 2018, the first cowpea seed trial involved 100 kg of source seed. Although there is also demand for wheat, there is not enough water to produce wheat in large volumes; in addition, the wild rhinoceroses that live in the surrounding areas sometimes damage wheat crops. In the last few years, operations were affected by the impact of the COVID-19 outbreak, but the expectation is that the activities will gradually return to normal, and production and sale levels will increase.

#### 3.1.4. Community Seed Banks and the Champion Farmer Seeds Cooperative in Zimbabwe

The policy environment in Zimbabwe is relatively supportive of farmer seed initiatives, with certain restrictions. The Seeds Act of Zimbabwe (Chapter 19: 13) allows farmers to save, use, exchange, and sell farm-saved seeds locally in their communities, but not beyond. The Seed Act states that farmer seed can only be sold within a radius of 10 km from where it was grown. However, there are a few exceptional instances where the Government of Zimbabwe may allow the distribution and sale of farmer varieties throughout the country. The conditions for this are: (1) only if there is a shortage of seed of a particular crop within the country, (2) only seed of known crop varieties can be distributed, and (3) the seed must be sold as “Standard Graded Seed,” which affects the price. The Agricultural Extension Service of the Ministry of Agriculture supports seed collection by community seed banks, which conserve, produce, and sell seeds. Community-based seed production plays an important role in the seed supply system of smallholder farmers, as community seed banks offer access to local varieties, including seeds improved through participatory variety selection and plant breeding. Farmers have access to improved material from national and international research organizations that also offer technical training to community seed bank members. Farmers benefit from learning advanced seed conservation technologies and are able to generate income from the sale of seeds, although certain restrictions apply. Through field schools, farmers work closely with researchers and extension officers to further develop and improve their seeds by participatory action research. This work is in collaboration with the government’s Crop Breeding Institute and international research centers.

The NGO Community Technology Development Trust (CTDT) first stimulated farmer seed production and distribution in the 1990s, but initial attempts were not very successful. After the establishment of the first community seed bank in Uzumba-Maramba-Pfungwe (UMP) province in 1999 [29], more systematic organizational and entrepreneurial work took place, which was complemented by farmer field schools. In later years, other community seed banks were established; by the middle of 2019, there were 14, the most recent of which was established in 2017 in Chemazumba, UMP, with Dutch funding. The objectives of the community seed banks were to: (1) promote knowledge and seed exchange; (2) facilitate local crop experimentation by farmers; (3) store germplasm of importance to communities. As such, community seed banks are seen as a collective framework and institutional platform for local decision-making and a mechanism to implement farmers’ rights as defined by the International Treaty on Plant Genetic Resources for Food and Agriculture.

Community seed banks produce seed by using the “cluster method,” where farmers take responsibility for producing seed of one to four crops on an area ranging from 0.2 to 0.6 ha. Currently, crops include Bambara nut (*Vigna subterranea*), cowpea, groundnut, pearl millet (*Pennisetum glaucum*), finger millet, maize (open-pollinated varieties and, in some cases, hybrids), and sorghum. In many communities, seed produced through this method is sold locally, via the community seed bank, at seed fairs, and during field days. CTDT and the national extension service AGRITEX provide technical support. Farmers from the UMP community seed bank explained that this form of seed production has a primarily

social function: to make sure that everyone has access to good quality seed of crops that are important for smallholder farmers but are neglected by large seed companies.

In 2015, CTDI, in partnership with the NGO Oxfam Novib of the Netherlands, began designing a new company, Champion Farmer Seeds Cooperative, which was formally registered in 2016 and launched in 2017. Oxfam Novib developed the seed business model for the company. Champion Farmer Seeds Cooperative is both a commercial and social enterprise, with farmers as stakeholders and producers (on a contract basis) and buyers of good quality, certified seed of highly adaptable and high-yielding varieties of dryland grains and legumes. CTDI is leading the development of the company. Factors that played a role in the establishment of Champion Farmer Seeds were the high price of seed in commercial markets and the desire of farmers to become more food-secure through increased seed security. The current crop and variety portfolio of Champion Farmer Seeds includes:

- Maize: Hybrid ZS265, open-pollinated varieties (OPV) ZM521 and ZM309,
- Sorghum: Macia, SV4,
- Pearl millet: Okashana 1,
- Cowpea (*Vigna unguiculata*): CBC2,
- Bean: NUA 45, Sweet Violet,
- Groundnut: Ilanda, Njiva, Guinea fowl,
- Two new maize OPV varieties, Shasha 301 and Shasha 302, are currently in trials, which will be exclusive to the company.

Champion Farmer Seeds Cooperative, as a registered seed company, must abide by the laws of Zimbabwe with regard to seed production. Concerning seed quality, the company follows guidelines set by the Seed Certification Scheme, 2000. These set out minimum standards required in seed production to ensure that seed quality is maintained and standards adhered to. Some of the elements included are crop rotations, isolation distances, rouging of off-types, and general crop management. To ensure that high quality is maintained, the company provides foundation seed to farmers. This ensures that the farmer grows only true-to-type seed. During the growing period of the crop, field visits by the company's personnel ensure that the farmer is adhering to the standards set. In addition, all seed crops grown in Zimbabwe, as enshrined in the Seed Certification Scheme, have to be inspected at least twice by government seed inspectors before they are harvested.

Inspections are also carried out during harvesting, packing, and storage phases, in situ, thus at farmers' homes, to ensure there are no admixtures with other crop varieties. All bags are labeled with the farmer's name and crop variety. Name tags are attached to each bag and placed inside the bag to allow traceability if needed. Another requirement of the guidelines is that all seed should be tested for purity and germination in a government-certified laboratory before sale. After treating and packing by Champion Farmer Seeds Cooperative, all bags are carefully labeled indicating the variety name, with another name tag placed inside each bag. This tag includes information about the name of the variety, purity, germination test results, and year of testing.

After four years of operation, while still benefitting from Oxfam Novib support, the company had made good progress toward organizational and financial sustainability. In its first two years of operation, the company produced almost 150,000 Mt of certified seed per year. However, in 2020, the COVID-19 pandemic hit the world and the effects of the outbreak in Zimbabwe on the operations of the company were multiple. The Government of Zimbabwe's measures meant that physical meetings were limited to 25 persons gathered at a time and place. Seed grower training had to be scheduled in many subsequent sessions to deliver training to the almost 2000 growers contracted by the company. Particular attention was paid to the training needs of new growers and of growers growing new crops, with which they were not familiar. Overall, more time and financial resources were needed to finalize the training; an unforeseen result of the pandemic.

During several intervals of time in 2020 and 2021, when the number of infected persons went up again, the Government of Zimbabwe banned all physical meetings. This dramati-

cally affected company board meetings, staff reporting to office blocks, the organization of field days, and the participation of staff and seed producers in physical exhibitions. The company responded to this situation by resorting to virtual means of working and marketing seed. Other measures, such as the requirement to purchase protective materials (face masks, sanitizers, and disinfectants) led to increased business expenditures. However, not all was negative, given that the Government of Zimbabwe classified the national seed industry as an important sector in the country, facilitating permissive letters, some restricted movement of seed staff for field seed inspections, the movement of seed into factories, and from the factories out to the markets. During the various lockdowns, the seed value chain more or less managed to continue its operations, although transport prices went up, affecting profit margins.

Despite the challenges encountered in the last two years, the company's seed sales have been good and are on the rise. In the 2020–2021 season, 414 MT of seed were produced of which 96 percent had been sold by 31 December 2021. The future prospects are good, according to a company representative (Tsongai Bwerazuva, personal communication, 27 May 2022), with a growing demand for the company's seed from various sectors, which is based on strong private-public partnerships that the management team has established since the start of the operations. The company is growing organically, based on the financing of its operations without external credit. It plans to expand operations to other crops and other seed-related activities, as envisioned by the board of directors.

#### 4. Discussion and Conclusions

With reference to the conceptual framework presented in the Materials and Methods section, the main characteristics of the four case studies are presented in Table 1, scored on a scale of low (\*), medium (\*\*), or high (\*\*\*). Scores are based on a qualitative assessment of the case studies.

**Table 1.** Qualification of the main characteristics of the case studies, scored as medium (\*\*), or high (\*\*\*).

	India	Uganda	Nepal	Zimbabwe
Sustained demand for quality seed	***	***	***	Promising so far and on the rise
Availability of improved source materials	***	***	***	***
Adequate management capabilities (technical, entrepreneurial, institutional)	***	***	***	Satisfactory so far
Local ownership and recognition of women	***	***	***	***
Social and economic profitability	**	**	**	Profit margins are slowly increasing
Beneficial intersectoral relationships	**	***	***	***
Effective communications and branding	***	**	**	***
Conducive policy and legal environment	***	**	**	**

The case studies point to the viability of community seed banks as seed producers and distributors, and new seed actors in the national seed sector of the four countries, but becoming successful is difficult and depends on several factors (managerial, technical, financial, social, policy-related). Initial technical and financial support provided by a committed and experienced organization, such as ASA in India, LI-BIRD in Nepal, NARO

and Bioversity International in Uganda, and CTDI in Zimbabwe, can facilitate the effective launch and early development of the enterprise. Unsurprisingly, smallholder farmers often lack the technical, financial, and organizational capacities to launch a company and scale seed production and distribution to a level beyond the household or community. To make this step requires some form of targeted guidance and support—a nurtured seed development pathway. A similar argument has been made in a review of the evolution of informal seed producers to formal private seed cooperatives in Ethiopia [30]. Successful development also requires ample time for setting up the infrastructure, organization, governance, and market relationships; the latter require the development of an effective communication strategy (by making use of local media, e.g., farmer radio) and clear branding of the products (e.g., *Champion Seeds* can be seen as an attractive brand name).

Government and development organizations can play an important role by providing technical and financial support for local seed business development that allows organized smallholder farmer groups, such as community seed banks, to enter the national seed market and contribute to integrated seed sector development. Challenges include the often cumbersome and costly process of having local varieties formally registered before they can be commercialized on a larg(er) scale; while the sale of non-registered is not allowed anywhere and systems with alternatively registered farmer varieties, are still in their infancy. The case studies also highlight that even in very demanding and uncertain times, such as those caused by the COVID-19 outbreak, operations can be maintained and even grow (India and Zimbabwe cases), when supported by a conducive environment (i.e., Indian government departments and district authorities supporting the outscaling of efforts; the Government of Zimbabwe declaring the seed sector a priority sector). Farmer seed producer champions (women and men) can act as trainers of other farmers and as catalysts of change and mainstreaming.

An unforeseen result of the COVID-19 outbreak was the realization by many social actors in the world of agriculture that many countries, provinces, counties, and communities are highly food and seed-dependent. When movements of people and goods (including seeds) were curtailed everywhere, this dependency became a major stress factor for governments and societies, triggering reflection and discussion about measures to alleviate the stress and increase the capacity to become less dependent and better prepared for the face of new disasters. Although too early to determine, these developments could favor the creation of a more conducive environment to attain national food and seed security through stronger reliance on national (integrated) seed sector development.

The case studies demonstrate that the initial development of a sound, integrated business plan is advised, but the use of blueprints should be avoided. In fact, from the case studies, several interesting models emerge. In India, the Farmer Producer Company model has proved successful. This model is based on the development of annual business plans, which are fairly comprehensive and take into consideration different components of the seed value chain, such as input procurement, seed production, and commodity trading. In Nepal, the production and sale of seed by the Agriculture Development and Conservation Farmers Committee started in 2015 as a means to generate income for local farmers who were members of the community seed bank and support for the Agyauli Community Seed Bank's operations in particular. Since 2015, production and sales volumes have seen an upward trend, based on the growing demand for the varieties on sale. After interactions with scientists from NARC, some new (to the region) varieties, e.g., Jhinuwa, have been introduced and tested on a small scale in farmers' fields. The area of Jhinuwa cultivation will be expanded and further diversification of crops and varieties will be explored.

The Kiziba case study is another example of a specialized seed enterprise that emerged from a community seed bank, owing to its relative success to very good relationships with entities of the formal seed sector and with government (research) organizations. The Joy and Family Demonstration Farm in Uganda is an example of a homegrown experience, with its strong roots in a community seed bank, but now on a track of novel enterprise development. This case study demonstrates the potential opportunities stemming from community seed

banks and shows that dedication and expertise, combined with sound and timely technical support and clever social networking, can be instrumental in effective seed enterprise development. The two Ugandan case studies also help to illustrate the importance of the institutional context of government research and extension, policies, and laws. Overall, in Uganda, there is an open and supportive institutional context, which recognizes and provides space for multiple seed actors and activities beyond the conventional commercial sector. Very few countries have clear and supportive rules and regulations in place that encourage, recognize, facilitate, and guide community-based seed entrepreneurship, such as that spearheaded by members of community seed banks.

In Zimbabwe, a unique model is being pursued through the establishment of the Champion Farmer Seeds Cooperative, formally registered in 2016 and launched in 2017. This company builds on the rich experiences of the community seed banks supported by CTDT but has an independent status. Champion Farmer Seeds is both a commercial and social enterprise, with farmers (including community seed bank members) as shareholders, producers (on a contract basis), and buyers of good quality, certified seed of highly adaptable and high-yielding varieties of dryland grains and legumes. Champion Farmer Seeds sells improved farmer varieties and hybrids. This mix of seed types on sale is a clever marketing diversification strategy. It is too early to tell if this model will be successful in the context of Zimbabwe, but it is certainly an example of innovative entrepreneurial design.

The case studies suggest that conservation of agrobiodiversity can be combined with and benefit from seed production and distribution. However, success seems to require a broad set of mutually supportive activities, which together span the whole seed value chain. Developing a sound business plan and a seed value chain perspective requires time and effort, as well as learning by doing. The following activities should be considered from the start and be integrated as much as possible into the initial business plan:

- Well-planned multiplication of indigenous/local seeds, in particular of those with good nutritional value, market potential, and adaptive capacity,
- Dynamic seed conservation (on-farm, in a community seed bank), with the regular rejuvenation of the seed collection,
- Organizing local seed business farmers in production groups with careful attention paid to social and gender dimensions and dynamics, so that farmers can market and sell seeds together in a fair and equitable way,
- Effective seed distribution of promising, interesting, and high-value varieties, making good quality seed accessible and available to farmers at the right time and at an affordable price,
- Training farmers in all aspects of seed business development (not only in technical and financial aspects but also in ethics, socio-economics, politics),
- Engaging youth with an interest in entrepreneurship, engaging them in all training activities, and creating incentives and rewards to become successful young entrepreneurs.
- Doing crop research with partner organizations, such as NARO, LI-BIRD, and the Alliance of Bioversity International and CIAT, e.g., on improved conservation technologies and practices, integrated management of pests and diseases, crop improvement (variety selection, plant breeding), nutritional analysis, value addition, and adaptation to climate change,
- Developing collaboration with the national genebank and/or national plant genetic resource center to share seed and seed-related knowledge, engage in joint collection missions, and strengthen conservation capacities [31],
- Awareness-raising activities at local and national levels (e.g., seed fairs, workshops, conferences, media outreach),
- Advocacy activities to create more policy space and support for farmer seed entrepreneurship (media campaigns, policy for a, inviting policy-makers to visit the community seed bank and local seed business and participate in seed and food fairs) [32].

If all these requirements are followed, there are good prospects for a larger role of community seed banks as quality seed producers and sellers in national seed sector development, contributing to income generation, seed, and food security, socio-ecological resilience [33], and adaptation to climate change.

**Author Contributions:** Conceptualization, R.V.; methodology, R.V.; investigation, R.V., J.R., H.M., G.O. and P.S.; data analysis, R.V., J.R., H.M., G.O. and P.S.; writing—original draft preparation, R.V., J.R., H.M., G.O. and P.S.; writing—review and editing, R.V.; supervision, R.V.; project administration, R.V.; funding acquisition, R.V. All authors have read and agreed to the published version of the manuscript.

**Funding:** We acknowledge the funding support of the CGIAR Research Program on Grain Legumes and Dryland Cereals (GLDC), which is supported by CGIAR Trust Fund Donors ([www.cgiar.org/funders](http://www.cgiar.org/funders); accessed on 30 June 2022). This research contributed to work on improving the functionality of seed systems, which was co-led by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and the Alliance of Bioversity International and CIAT. Additional support was received from Integrated Seed Sector Development Africa funded by the Swiss Agency for Development and Cooperation, and the Government of the Netherlands.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Not applicable.

**Acknowledgments:** We acknowledge the research support provided by local partners in India, Nepal, Uganda, and Zimbabwe to carry out the case studies. Special thanks go to Tsungai Bwerazuva in Zimbabwe for updating the Zimbabwean case study. We thank the farmers who participated in the research activities for sharing with us their experiences and reflections on achievements and challenges. We thank Harri Washington for the editing support.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## References

1. Bisht, I.S.; Rana, J.C.; Yadav, R.; Ahlawat, S.P. Mainstreaming agricultural biodiversity in traditional production landscapes for sustainable development: The Indian scenario. *Sustainability* **2020**, *12*, 10690. [[CrossRef](#)]
2. Subedi, A.; Vernooy, R. Healthy Food Systems Require Resilient Seed Systems. In *Agrobiodiversity Index Report 2019: Risk and Resilience*; Bioversity International: Rome, Italy, 2019; pp. 127–134. Available online: <https://hdl.handle.net/10568/100820> (accessed on 31 January 2022).
3. International Fund for Agricultural Development (IFAD). *Lessons Learned: Supporting Smallholder Seed Systems*; IFAD: Rome, Italy, 2018. Available online: <https://www.ifad.org/ar/web/knowledge/publication/asset/40251103> (accessed on 31 January 2022).
4. Ojiewo, C.O.; Kugbei, S.; Bishaw, Z.; Rubyogo, J.C. (Eds.) *Community Seed Production. Workshop Proceedings, Addis Ababa, Ethiopia, 9–11 December 2013*; FAO: Rome, Italy; ICRISAT: Addis Ababa, Ethiopia, 2015.
5. Walsh, S.; Remington, T.; Kugbei, S.; Ojiewo, C. Review of Community Seed Production Practices in Africa. Part 1: Implementation Strategies and Models. In *Community Seed Production. Workshop Proceedings, Addis Ababa, Ethiopia, 9–11 December 2013*; Ojiewo, C.O., Kugbei, S., Bishaw, Z., Rubyogo, J.C., Eds.; FAO: Rome, Italy; ICRISAT: Addis Ababa, Ethiopia, 2015; pp. 3–28.
6. Walsh, S.; Remington, T.; Kugbei, S.; Ojiewo, C. Review of Community Seed Production Practices in Africa. Part 2: Lessons Learnt and Future Perspective. In *Community Seed Production. Workshop Proceedings, Addis Ababa, Ethiopia, 9–11 December 2013*; Ojiewo, C.O., Kugbei, S., Bishaw, Z., Rubyogo, J.C., Eds.; FAO: Rome, Italy; ICRISAT: Addis Ababa, Ethiopia, 2015; pp. 29–38.
7. Greenberg, S.; Pelsler, D.; Ranqhai, T. *Farmer-Led Seed Systems. Securing Food Sovereignty in the Face of Looming Ecological and Social Crises. Biowatch Briefing*; Biowatch South Africa: Durban, South Africa, 2021. Available online: <https://biowatch.org.za/download/farmer-led-seed-systems/> (accessed on 31 January 2022).
8. Neate, P.J.H.; Guei, R.G. *Promoting the Growth and Development of Smallholder Seed Enterprises for Food Security Crops: Best Practices and Options for Decision Making*; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2010. Available online: <http://www.fao.org/docrep/013/i1839e/i1839e00.pdf> (accessed on 31 January 2022).
9. Access to Seeds Foundation. *The Rise of the Seed-Producing Cooperative in Western and Central Africa*; Access to Seeds Foundation: Amsterdam, The Netherlands, 2020. Available online: [https://www.accesstoseeds.org/app/uploads/2018/10/081018\\_FAO\\_ATSreport-1.pdf](https://www.accesstoseeds.org/app/uploads/2018/10/081018_FAO_ATSreport-1.pdf) (accessed on 31 January 2022).
10. Thijssen, M.H.; Bishaw, Z.; Beshir, A.; de Boef, W.S. (Eds.) *Farmers, Seeds and Varieties: Supporting Informal Seed Supply in Ethiopia*; Wageningen International: Wageningen, The Netherlands, 2008.

11. Mushita, A.; Vernooy, R. Seed production and distribution. In *Resilient Seed Systems: Handbook*, 2nd ed.; Vernooy, R., Bessette, G., Otieno, G., Eds.; Bioversity International: Rome, Italy, 2019; pp. 83–97. Available online: <https://hdl.handle.net/10568/103498> (accessed on 31 January 2022).
12. Vernooy, R.; Shrestha, P.; Sthapit, B. (Eds.) *Community Seed Banks: Origins, Evolution and Prospects*; Routledge: London, UK, 2015. Available online: <https://cgspace.cgiar.org/handle/10568/68708> (accessed on 31 January 2022).
13. Joshi, B.K.; Shrestha, P.; Gauchan, D.; Vernooy, R. (Eds.) *Community Seed Banks in Nepal*. In *Proceedings of the 2nd National Workshop, Kathmandu, Nepal, 3–5 May 2018*; NAGRC: Entebbe, Uganda; LI-BIRD: Pokhara, Nepal; Bioversity International: Kathmandu, Nepal, 2018. Available online: <https://cgspace.cgiar.org/handle/10568/99141> (accessed on 31 January 2022).
14. ISSD Africa. *Making Business Out of Low-Profit Seed*; ISSD Africa Synthesis Paper. KIT Working Papers 2017-1; KIT: Amsterdam, The Netherlands, 2017. Available online: [http://www.issdseed.org/sites/default/files/case/issd\\_africa\\_twg1\\_sp1\\_seed\\_business\\_170412.pdf](http://www.issdseed.org/sites/default/files/case/issd_africa_twg1_sp1_seed_business_170412.pdf) (accessed on 1 May 2022).
15. Fu, Y.B. The vulnerability of plant genetic resources conserved ex situ. *Crop Sci.* **2017**, *57*, 2314–2328. [CrossRef]
16. Andersen, R.; Shrestha, P.; Otieno, G.; Nishikawa, Y.; Kasasa, P.; Mushita, A. *Community Seed Banks—Sharing Experiences from North and South*; DIVERSIFOOD: Paris, France, 2018. Available online: <https://www.fni.no/publications/community-seed-banks-sharing-experiences-from-north-and-south> (accessed on 1 May 2022).
17. Malik, S.K.; Singh, P.B.; Singh, A.; Verma, A.; Ameta, N.; Maloo, S.R.; Bisht, I.S. *Community Seed Bank: Operation and Scientific Management*; ICAR-National Bureau of Plant Genetic Resources: New Delhi, India, 2013.
18. Okori, P.; Munthali, W.; Madzonga, O.; Kulkarni, R. *Community Seed Bank—A Seed Delivery Model for Under-Invested Crops*; CGIAR Research Program on Grain Legumes and Dryland Cereals (GLDC): Hyderabad, India, 2022. Available online: <http://gldc.cgiar.org/community-seed-banks-a-seed-delivery-approach-for-under-invested-crops/> (accessed on 30 June 2022).
19. De Boef, W.S.; Dempewolf, H.; Byakweli, J.M.; Engels, J.M.M. Integrating genetic resource conservation and sustainable development into strategies to increase the robustness of seed systems. *J. Sustain. Agric.* **2010**, *34*, 504–531. [CrossRef]
20. Vernooy, R.; Jai, R.; Ahlawat, S.P.; Malik, S.K.; Mbozie, H.; Mugisha, J.; Nyabasha, S.; Otieno, G.; Patil, S.; Roy, S. *Community Seed Banks as Seed Producers: Cases from India, Nepal, Uganda and Zimbabwe*; Working Paper Series N-2; CGIAR Research Program on Grain Legumes and Dryland Cereals: Hyderabad, India; Bioversity International: Rome, Italy, 2020. Available online: <https://cgspace.cgiar.org/handle/10568/111420> (accessed on 31 January 2022).
21. Wageningen Centre for Development Innovation. Seed Alerts-Synthesis, Number 1. 17 June 2020. Available online: [https://www.wur.nl/upload\\_mm/e/d/b/a057c5ec-c309-4534-a606-c42566568252\\_Seed%20Sector%20Alert%20-%20June%20-%20Synthesis.pdf](https://www.wur.nl/upload_mm/e/d/b/a057c5ec-c309-4534-a606-c42566568252_Seed%20Sector%20Alert%20-%20June%20-%20Synthesis.pdf) (accessed on 31 January 2022).
22. Long, N. *Development Sociology. Actor Perspectives*. Routledge: London, UK, 2001.
23. Vernooy, R.; Shrestha, P.; Sthapit, B. Seeds to Keep and Seeds to Share: The Multiple Roles of Community Seed Banks. In *Handbook of Agricultural Biodiversity*; Hunter, D., Guarino, L., Spillane, C., McKeown, P.C., Eds.; Earthscan: London, UK, 2017; pp. 580–591. Available online: <https://cgspace.cgiar.org/handle/10568/90149> (accessed on 31 January 2022).
24. Maharjan, K.L.; Khanal, N.P. A Framework for Understanding Sustainability of Community-Based Seed Production. In *Community Seed Production. Workshop Proceedings 9–11 December 2013*; Ojiewo, C.O., Kugbei, S., Bishaw, Z., Rubyogo, J.C., Eds.; FAO: Rome, Italy; ICRISAT: Addis Ababa, Ethiopia, 2015; pp. 46–54.
25. De Jonge, B.; López Noriega, I.; Otieno, G.; Cadima, X.; Terrazas, F.; Hpommalath, S.; van Oudenhoven, F.; Shrestha, S.; Pudasaini, N.; Singh Shrestha, D.; et al. Advances in the registration of farmers’ varieties: Four cases from the Global South. *Agronomy* **2021**, *11*, 2282. [CrossRef]
26. Ramanna, A. *Farmers’ Rights in India: A Case Study*; FNI Report 6/2006; The Farmers’ Rights Project; The Fridtjof Nansen Institute: Lysaker, Norway, 2006.
27. Mastenbroek, A.; Otieno, G.; Ntare, B.R. Institutionalizing Quality Declared Seed in Uganda. *Agronomy* **2021**, *11*, 1475. [CrossRef]
28. Shrestha, P.; Rana, R.B. Community seed banks in Nepal: Safeguarding Agricultural Biodiversity and Strengthening Local Seed Systems. In *Community Seed Banks in Nepal. 2nd National Workshop Proceedings, Kathmandu, Nepal, 3–5 May 2018*; Joshi, B.K., Shrestha, P., Gauchan, D., Vernooy, R., Eds.; NAGRC, LI-BIRD and Bioversity International: Kathmandu, Nepal, 2018; pp. 21–44.
29. Mushita, A.; Kasasa, P.; Mbozi, H. Zimbabwe: The Experience of the Community Technology Development Trust. In *Community Seed Banks: Origins, Evolution and Prospects*; Vernooy, R., Shrestha, P., Sthapit, B., Eds.; Routledge: London, UK, 2015; pp. 230–236.
30. Akpo, E.; Feleke, G.; Fikre, A.; Chichaybelu, M.; Ojiewo, C.O.; Varshney, R.K. Analyzing pathways of nurturing informal seed production into formal private ventures for sustainable seed delivery and crop productivity: Experiences from Ethiopia. *Sustainability* **2020**, *12*, 6828. [CrossRef]
31. Westengen, O.T.; Skarbø, K.; Mulesa, T.H.; Berg, T. Access to genes: Linkages between genebanks and farmers’ seed systems. *Food Secur.* **2018**, *10*, 9–25. [CrossRef]
32. Vernoy, R. *Options for National Governments to Support Farmer Seed Systems. The Cases of Kenya, Tanzania and Uganda*; Hivos: The Hague, The Netherlands; Bioversity International: Rome, Italy, 2017.
33. Porcuna-Ferrer, A.; Fiala, V.; Freyer, B.; van Etten, J.; Vernooy, R.; Probst, L. Do community seed banks contribute to the social-ecological resilience of communities? A case-study from western Guatemala. *Int. J. Agric. Sustain.* **2020**, *18*, 232–249. [CrossRef]