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Analyzing Pathways of Nurturing Informal Seed Production into Formal Private Ventures for Sustainable Seed Delivery and Crop Productivity: Experiences from Ethiopia

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Abstract: Sustaining crop production and productivity in sub-Saharan Africa requires the availability and use of quality seed of improved varieties by smallholder farmers. The private sector has been considered as the best way to sustain seed supply and crop productivity. Unfortunately, the private sector's share in the seed production and delivery in sub-Saharan Africa countries has not been very substantial for decades. As a consequence, farmer access to quality seed of recently released varieties remains very low. This manuscript analyzes the experiences of informal seed producers who graduated to formal private seed enterprises to understand the effectiveness of the support they receive to become viable seed ventures. We used comparative research methods to analyze the qualitative and quantitative data collected to understand the underlying mechanisms. The findings showed that the analyzed seed enterprises started with as little as about USD 300 and have already multiplied over tenfold their initial capital. They benefited from a wide variety of supports, e.g., quality seed production, marketing, partnerships, and value chain development trainings and infrastructures, from extension workers, research centers, national and international NGOs, and the other private seed enterprise operators like large public seed enterprises and agro-dealers. The seed enterprises are producing pre-basic, basic, and certified seed of cereals and self-pollinated legume crops delivered directly to farmers, institutional markets, and agro-dealers. The seed production data have been increasing for the past three years with an area expanding from about 30 ha to over 150 ha per year for chickpea. The seed production and delivery practices being employed are smallholder farmer-based practices that are environmentally friendly. For sustainable and reliable seed production and delivery systems in sub-Saharan Africa, a bold step is needed whereby the informal seed production entities are nurtured and upgraded into formal certified seed production ventures that deliver social and economic benefits to the promoters and the communities.

Keywords: seed enterprise incubation; sustainable seed systems; smallholder farmers; dryland agriculture; East Africa

1. Introduction

Sustaining crop productivity for food and nutrition security is a major goal in the development agenda of sub-Saharan Africa (SSA) countries. Agricultural intensification with quality inputs is

perceived as a promising path forward. Unfortunately, for decades, about 80% of smallholder farmers in the developing countries of SSA use traditionally saved, often unimproved variety seeds for planting, while at the same time, substantial breakthroughs have been made by breeding programs [1,2]. The several hurdles to ensure sustainable seed production and consistent flows of improved legume varieties in SSA involve the unreliable demand, self-pollinated nature of most grain legumes, and slow variety replacement rate by smallholder farmers [3]. As a consequence, the smallholder farmers' access to the outputs of the breeding programs' achievements has been very weak as private seed companies lack incentives to invest in legume seed business. The low interest of the private seed companies to pick up and disseminate seed of improved varieties of grain legumes is a major challenge for the sustainable development of the seed sector for enhanced production and productivity in SSA. Even though many superior grain legume technologies have been developed, the level of involvement of the private sector and seed producers to consistently incorporate them into their business is still very low in most countries, including Ethiopia.

While the private sector has made significant efforts in the seed industry during the past decade, most of them were specifically geared toward maize [4]. Obviously, the private seed companies are limited to a few crops in a country like Ethiopia, with very little attention to grain legumes like chickpea, a major commodity for farmers. Recent statistics show that the private seed sector contributes about 32% of the total formal seed supply in Ethiopia [5] with the volume of seed produced by private producers estimated to have increased from about 5000 tons in 2012–2013 to around 9800 tons in 2014–2015 [6].

In Ethiopia, seed producer cooperatives are the main players in the seed supply chain. Seed producer cooperatives (SPCs) are enterprises established by groups of individual farmers. The SPCs produce seeds of cereals, vegetables, and legumes for which an output market exists. The SPCs have a comparative advantage of delivering seed to farming communities at affordable prices [6]. To complement and expand the seed production and delivery work of the SPCs, some members of seed producer groups have been recently supported to graduate to formal seed enterprises. Such experiences are worth documenting to share the ongoing dynamics in the Ethiopian seed sector development to inform current and future interventions for sustainable seed sector development in SSA. This paper aims to bring to light the key features pertaining to the path the seed enterprises went through to become a formal seed production and delivery unit serving hundreds of farmers who are improving agricultural productivity in Ethiopia. The three main questions that guided this research were: (i) What are the main characteristics of the analyzed seed enterprises? (ii) What array of supports permitted their shift from informal to formal ventures? (iii) What can we learn from the experiences of these seed enterprises to sustain seed delivery systems in sub-Saharan Africa countries, including Ethiopia?

2. Context of the Ethiopian Seed Sector Development

Like most farmers in developing countries, the Ethiopian farmers have used their own saved seed from the previous harvests or obtained them from neighbors or family members for the new planting season [7,8]. Usually seed transactions may involve exchanging grain of another commodity [9]. Though well-adapted to the local agro-ecological situations, and household uses or even moisture stress, "land races" are generally low-yielding when compared to modern high-yielding varieties. Bred at agricultural research stations, modern varieties have a relatively wider adaptability to a range of environments and are responsive to the application of inputs like fertilizers [10,11].

Until 1979, there was no organized entity responsible for seed supply in Ethiopia [12]. From 1979, the Ethiopian Seed Corporation, then the Ethiopian Seed Enterprise (ESE), was established to produce and distribute quality seed of improved varieties to meet the national demand of state farms, farmer cooperatives, and individual farmers. Though ESE, a parastatal enterprise, was responsible for producing seed for all crops (cereals, pulses, fruits, vegetables, and forage), it was dominated by cereal seeds, mainly maize and wheat. ESE produces seed on its own farms across the country but also through contracts with public and private farms, cooperative unions, and small-scale farmers.

By 2016, ESE produced pre-basic, basic, and certified seed of 25 crops and 137 varieties [13]. In the last 5–10 years, the Ethiopian seed system has seen a surge in production volumes of certified seed over fivefold [6]. Four Regional Seed Enterprises (RSEs) have been established to decentralize seed supply to regional states since 2009 [14]. They invest little in legume crops like chickpea but mainly focus on hybrid maize, bread wheat, teff, and barley.

Currently, the Ethiopian seed system can be categorized into two main sectors. First, the formal sector is made up of institutional operations associated with the development of improved varieties, multiplication, processing, storage, and distribution to farmers. As in most countries, it involves research institutions, public seed enterprises, large private corporations, and small private seed enterprises [15]. In Ethiopia, the formal seed sector started developing about five decades ago in the late 1960s and early 1970s, whereby many private large-scale commercial farms developed, which were eventually nationalized by the socialist Dergue government [12]. During that period, in some parts of the country the then-government established new state farms based on socialist principles. Farmer cooperatives were also organized, and farmer settlement projects launched. Those developments led to increased demand for modern agricultural inputs, particularly improved variety seeds. Second, in the informal sector farmers select their crops and landraces, produce their own seeds, locally exchange or purchase seeds. In most SSA countries, the informal sector remains the mainstay for many crops grown by smallholder farmers [15–17].

A third category is identified and is an intermediate sector, which has distinct yet overlapping features with the previous two sectors. It involves community seed production by farmer groups with higher quality seed than the ones produced by the informal sector [18]. This category offers a unique opportunity for meeting seed needs and should not be seen merely as part of the informal sector. It is among these community seed producers that some took the bold step to upgrade their seed businesses to a private seed enterprise, thanks to various supports received from research and development partners.

Recently, the Ethiopian government policy has been encouraging the private sector to invest in agricultural intensification, including variety development, seed production, and marketing [19]. The government is working also to promote well-functioning cooperatives, which play a major role in providing farmers with inputs while ensuring members' social cohesion and economic well-being [20]. Overall, the number of primary cooperatives has increased across the years from 7366 in 1991 to 60,126 in 2015 [21]. Seed producer cooperatives (SPCs) are specialized cooperatives for seed businesses [9] and aim to accomplish together a common goal that would be impossible to members individually [22]. The SPCs fall under the category of intermediary seed sector in Ethiopia [23,24]. They share similarities and variations regarding agro-ecological conditions, sociocultural context, farming facilities, market demand, technical, managerial, and financial capabilities, infrastructure development, credit access, external support, and experiences [25].

3. Theoretical Framework

Several definitions have been given to business nurturing or incubation by various institutions. Incubators exist to support the transformation of selected, early stage businesses with high potential into self-sufficient, growing, and profitable enterprises [26]. The incubator reduces the risks during the early stage of business formation, contributes to economic growth through sustaining enterprises that otherwise fail due to a lack of adequate support [27]. A business incubator is an organization that accelerates and systematizes the process of creating successful enterprises by providing for them a comprehensive and integrated range of support, including incubator space, business support services, clustering and networking opportunities [28]. The "one stop shop"-basis services enable significant improvement of the survival and growth prospects of new start-ups [26]. A property-based venture provides a range of services to entrepreneurs and start-ups, e.g., physical infrastructure, management support, technical support, access to finance, legal assistance and networking [29].

From these different perspectives, we consider a business incubator as a mechanism that enables a business initiative to mature and grow into a viable entity through various kind of critical supports at the early stage [30]. Business incubation has become a common model used in Africa [31,32]. In the case of Ethiopia, incubating business is a relatively new concept, as in many other African countries. Ethiopia has a handful of incubation centers owned mostly by the government, like the Ministry of Communication and Information Technology and public universities [33]. Such initiatives play a vital role in promoting entrepreneurship in the country, which ultimately contributes to the overall development of the economy. The scope of the incubator in Ethiopia is also limited to agribusiness products and services, e.g., seed companies, equipment manufacturers, service providers, extension and training services, and commodity processing, rural digital financial and information services [33,34].

Agribusiness incubation entails working directly with early stage agri-enterprises and facilitating their growth through a number of services, e.g., shared facilities and equipment, business development, technology, finance, mentoring, networking [35]. Agribusiness incubation can be utilized to accelerate the commercialization and modernization of agriculture and to develop a competitive agribusiness sector in developing countries [36,37]. Agribusiness incubation, or the expansion of private sector investment in agriculture, can play an important role in the agricultural transformation of developing countries [36–38]. These various facilitated supports significantly waive many transaction costs that play major roles in the overall survival of firms, most importantly at their early stage [39]. Reducing transaction costs is a major component of keeping early stage agri-enterprises in business, including the cost of access to relevant information to profitably deliver goods and services to the market [40]. Various areas of transaction costs, e.g., information, partnerships with other business entities, taxes, production contracts [39], that are borne by support organizations through projects make the early stage business still profitable to some extent.

In Ethiopia, smallholder farmers represent the often overlooked actors in agribusiness incubation. Small farms tend to have lower labor costs, mixed-cropping systems with higher levels of crop diversity, including low inputs that preserve people's health and environment. As small farmers move into commercial production, they tend to specialize in higher-value crops as the requirement for inputs increases. Consequently, networks of low-input smallholders may, on average, produce a given quantity of crop at a lower cost than a single large high-input farm. High transaction costs associated with negotiating contracts and transporting goods, however, often inhibit smallholders from benefiting from local, regional, and national commercialization [41]. One response is for smallholders to organize into marketing cooperatives to reduce transaction costs and increase competitiveness at the production stage of crop value chains.

In this study, we analyzed the main support areas for agribusiness incubation. We went further to include additional lenses for a full understanding of the ongoing dynamics. They include firm profile and life history, objective and vision in the future, the main activities conducted and scope, the various partnerships involved, the support benefited, and finally the challenges hindering progress. We also investigated their seed production schemes and practices to take stock of their environmental sustainability. All these variables are reported to influence performance and survival of incubates [42–45].

4. Methods of Data Collection and Analysis

4.1. Data Collection Tools

We used key informant interviews to gather data from mid-December 2018 to early February 2019. Initiators, managers of seed ventures were met on-site and actively engaged to understand the underlying dynamics that propelled their seed production entities to the current level of operations. Four seed enterprises, of which two private and two cooperatives producing certified seed, were the cases investigated in this study. To gather further information on the performance of the seed enterprises, we also interviewed research institutes, extension and NGOs working closely with the

target seed ventures to capture their external views and cross-check narratives. All data were captured using semi-structured questionnaires composed mainly of direct questions, but also a few open-ended questions whereby interviewees' responses were jotted down.

4.2. Data Collected, Synthesis and Analysis

Data collected in this study involved (i) the life history of seed enterprises and initiators, (ii) the objective and vision for the coming 10 years, (iii) the crop portfolio involved, (iv) the business linkages, partnerships, and geographical coverage, (v) the types of supports received so far, and (vi) the main challenges and perspectives [46]. The social economic benefits to the communities were also key variables [30]. The perceptions of research institutes, extension and NGOs staffs were gathered to further analyze the performance of the seed ventures.

Data were analyzed using qualitative methods. We used comparative research methods to analyze the collected data and to understand the dynamics that led to the reported experiences [47,48]. Descriptive comparisons, basic explanatory analysis, comparison of relations, and comparative explanatory text as outlined by scholars [48] were used to understand the underlining mechanisms. Quantitative data like seed production and marketing statistics were analyzed using comparative tables, graphs, and descriptive comparisons over the past three years to understand the scope and consistency in seed production and delivery. Non-quantitative data were analyzed using narratives. For comparison across cases, we brought data collected for the same variable into the same tables. We also use a seven-point Likert scale to rank and weigh the top five constraints seed enterprises are facing, with the most critical challenge having the highest number of points, being seven [49,50].

4.3. Limitations to This Study

This research involved the seed enterprises that evolved from informal producers to formal ventures. Only the few seed ventures covered by the intervention were considered in this study. Subsequently, this limited the possibility of conducting more quantitative analysis. Though limited seed enterprises were involved in this research, the disaggregated and detailed analysis of the dynamics, through qualitative methods, permitted us to provide robust analysis and insights to show the path to developing sustainable seed ventures in sub-Saharan Africa, where availability and use of quality seed of improved varieties remain persistent challenges.

5. Major Findings

In this section, we present the main features characterizing the four cases investigated, variable-wise. For anonymity in the data presentation, PLC 1 and PLC 2 are used for the two private limited companies. In the same vein, COOP 1 and COOP 2 are adopted for the two cooperatives.

5.1. Profile and Life History of Seed Enterprises

The seed enterprises analyzed in this study were recently created, with the oldest being 13 years old while the youngest one is only two years old (Table 1). They are owned by groups of 10 to 38 farmers who decided to emerge from the informal to the formal sector to strengthen the Ethiopian seed sector. These farmers are among the ones helping researchers to demonstrate new crop technologies. Beyond seed, the private limited companies intend to supply other agro-inputs in the future. Membership has increased from two- to fivefold for the cooperatives. The private limited companies have kept their number unchanged (10 to 12 members) for better management. The modality of operation itself limits the new membership registration processes. The progress made in a short period of time is measured by the estimated seed enterprise capital, which has increased up to tenfold (e.g., PLC 1) and up to 400-fold for the cooperatives (e.g., COOP 1) (Table 1). Up to now, all seed enterprises are still active. The main motive for the seed enterprises is to fill in the gap between demand and supply of seed of new varieties.

Table 1. Comparative analysis of the profiles of the seed enterprises in Ethiopia in 2018.

Variables	Private Limited Company (PLC) 1	PLC 2	Cooperative (COOP) 1	COOP 2
Year of creation	2012	2017	2006	2012
Type of enterprise	Private Limited	Private Limited	Farmer cooperative	Farmer cooperative
Current location of headquarters	Bisheftu/Debre Zeit, Oromia Regional State	Ude Denkaka, Oromia Regional State	Ejere, Oromia Regional State	Ada, Oromia Regional State
Individual or Group-owned	Group-owned	Group-owned	Group of 26 individual farmers	Group of 38 individual farmers
Other supplies than seed	Animal feeds to the market and provide organic fertilizers (future)	Agro-processing industries (in the future)	None	None
Background of the initiators	12 shareholder farmers	10 shareholder farmers	Food crop farmers	Food crop farmers
Background of other members or shareholders	7 Model farmers	3 Model farmers	Food crop farmers	Food crop farmers
Membership at the beginning	12	10	26	38
Current membership (early 2019)	12	10	128	81
Starting capital	About USD 3700	About USD 18,500	About USD 300	About USD 450
Company size	About USD 50,000	Over USD 37,000	About USD 137,000	About USD 78,000
Main drivers	Big gap, better seed supply and availability	Mismatch between demand for seed by farmers and availability	Non-availability of seed for farmers in communities	Non-availability of seed for farmers in communities

5.2. Prospective of Seed Enterprises

All seed enterprises investigated have a clear idea of what they will look like in the future. All seed enterprises envision themselves to be one of the top suppliers of quality seed to Ethiopian farmers nationwide (Table 2). Delivering seed of improved varieties that are high-yielding, with farmer- and consumer-preferred traits, is key to their missions. To deliver on those missions, variety demonstrations, promotional activities, close engagement with smallholder farmers and other business partners constitute the menu of their daily activities. Out-grower seed production schemes, technical backstopping of seed producers, enhancing learning platforms among business partners are the pillars of their delivery strategy.

Table 2. Comparative analysis of visions and strategic approaches of the seed enterprises in Ethiopia in 2018.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Vision	Being a role model and center of excellence in the Ethiopian seed system	Become a solver of the quality seed production problem and an exemplary producer and marketer of improved agricultural technology	Being a highly ethical and quality agri-service provider to farmers and other clients and a role model for the Ethiopian seed system	Being a quality service provider to farmers nationwide in Ethiopia

Table 2. Cont.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Mission	<ul style="list-style-type: none"> - Multiply improved high-yielding and farmer-preferred varieties of food and forage crops - Produce desired livestock strains/breeds of dairy, poultry, swine, honeybees - Provide organic fertilizers to avail healthy animal and crop products for consumers - Produce and supply animal feeds to the market - Conduct the necessary research and generate preferred varieties of crops that are suitable for smallholder farmers 	<p>Ensure the profitability of the company in a sustainable manner along with increased benefits of participating and beneficiary farmers</p>	<ul style="list-style-type: none"> - Multiply improved high-yielding and farmer-preferred varieties of crops - Promote and work with private seed producers - Provide desirable crop seed for farmers and other clients 	<ul style="list-style-type: none"> - Multiply improved high-yielding and farmer-preferred varieties of crops - Provide desirable varieties to farmers and other clients
Objectives	<p>Demonstrate, promote and supply improved agricultural technologies, especially improved seeds of cereals and pulses</p>	<p>Promote use of improved agricultural technologies by engaging smallholder farmers in technology multiplication, demonstration using contract farming; provide short-term training, consultancy and advisory services; supply advanced agricultural equipment; conduct selection of appropriate varieties suitable for different agro-ecologies</p>	<p>Provide quality seed production and sustained services to every customer; generate income and improve the livelihood of members</p>	<p>Make seed a commercial and common produce for farmers; market quality seed to local and outside markets and improve the livelihood of members</p>
Strategic approach	<ul style="list-style-type: none"> - Produce seed through out-growers scheme based on farmers' interests - Employ the cluster approach that enhances technology uptake - Provide technical backstopping for farmers and front-line extension workers - Use different sizes of seed packs that meet customers' needs - Promote and work with agro-dealers 	<ul style="list-style-type: none"> - Adapt available agricultural technologies to field conditions - Demonstrate adapted new technologies to create demand - Promote demand-driven agricultural technology production and marketing - Play catalytic roles in developing and forming learning alliance with NGOs 	<ul style="list-style-type: none"> - Yearly increase of seed producers - Involve wide field of experts in the cooperative seed business - Target and serve farmers nationwide - Transition to private seed company 	<ul style="list-style-type: none"> - Invest in advanced agri-technologies - Expand production and productivity of crops under medium and long-terms

5.3. Portfolio of Crops, Seed Production, and Marketing

Most seed enterprises have chickpea, a self-pollinate legume, in their seed business and are still producing it. The four crops embraced are chickpea, teff, lentil, and wheat (Table 3). The seed enterprises produce a wide number of varieties, e.g., up to five, seven, and nine varieties of wheat, chickpea, and teff, respectively. Pre-basic, basic, and certified seeds are the different seed classes produced either through out-grower schemes or own farms. The out-growers are mainly smallholder seed producers who make limited use of inputs. Direct sales to farmers, farmer cooperatives, seed producer groups and agro-dealers are the main seed distribution channels. Regional seed enterprises, NGOs, cooperative unions, government, research centers, and individual farmers are the main buyers of seed. The seed production capacity varies between around 150 to 350 ha per year. Between 2016 and 2018, seed production has increased for chickpea (Figure 1).

Table 3. Seed production profiles of analyzed seed enterprises in Ethiopia in 2018.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Crop portfolio at business outset	Chickpea, teff	Chickpea, lentil, teff	Teff, wheat	Chickpea, lentil
Current crop portfolio	Chickpea, teff, wheat	Chickpea, lentil, teff	Chickpea, lentil, teff, wheat	Chickpea, lentil, wheat, teff
Varieties produced per crop	Chickpea: Arerti, Ejere, Habru, Teketay, Dalota, Minjar Teff: Quincho, Cr-37, Boset, Kora, Magna, Simada, Dagim, Negus, Filagot Wheat: Utuba, Mangudo, Udde, Kingbird, Wane	Chickpea: Arerti, Ejere, Habru, Teketay, Dalota, Natoli, Hora Lentil: Alemaya, Dershe Teff: Quincho, Cr-37, Boset, Kora, Dagim, Negus, Tsedey	Chickpea: Arerti, Habru, Lentil: Alemaya Teff: Quincho Wheat: Kekeba	Chickpea: Arerti, Ejere, Habru, Natoli Lentil: Alemaya Teff: Quincho, Cr-37, Boset Wheat: Utuba, Mangudo
Seed classes produced	Pre-basic seed, basic seed, certified seed	Pre-basic seed, basic seed, certified seed	Pre-basic seed, basic seed, certified seed	Pre-basic seed, basic seed, certified seed
Seed production models	- Own plot - 500 out-growers	- 100 out-grower farmers - Seed producers' cooperatives	- Individual members' farms	- Individual members' farms
Seed distributors	- Direct sale - Primary cooperatives - Cooperative unions - Agro-dealers	- Direct sale - Primary cooperatives - Cooperative unions - Women seed producers - Youth group seed producers	- Direct sale - Private seed producers - Cooperative unions - Agro-dealers	- Direct sale - Cooperative unions - Agro-dealers
Main clients	- Farmers - Regional seed enterprises - Farmer cooperative unions - Institutional buyers: NGOs, Government, Research centers	- Farmers - Institutional buyers: Government, NGOs and Research centers	- Farmers - Ethiopian seed enterprise (ESE) - Institutional buyers: Research centers and NGOs	- Farmers - Ethiopian seed enterprise (ESE) - Institutional buyers: Research centers and NGOs
Seed production acreage in 2018, all crops included (ha)	300	147	-	340

Table 3. Cont.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Pre-order arrangements through contracts	Basic seed produced under contract with research centers and cooperative unions	Basic seed produced through direct contracts from research centers and cooperative unions	Contracted seed production with public (ESE and OSE), private seed companies, unions and NGOs	Contracted seed production with public (ESE, ASE, OSE, SSE), private seed companies, unions and NGOs

OSE: Oromia Seed Enterprise; SSE: South Seed Enterprise; ASE: Amhara Seed Enterprise; ESE: Ethiopian Seed Enterprise. -: Means that the seed enterprise did not avail data.

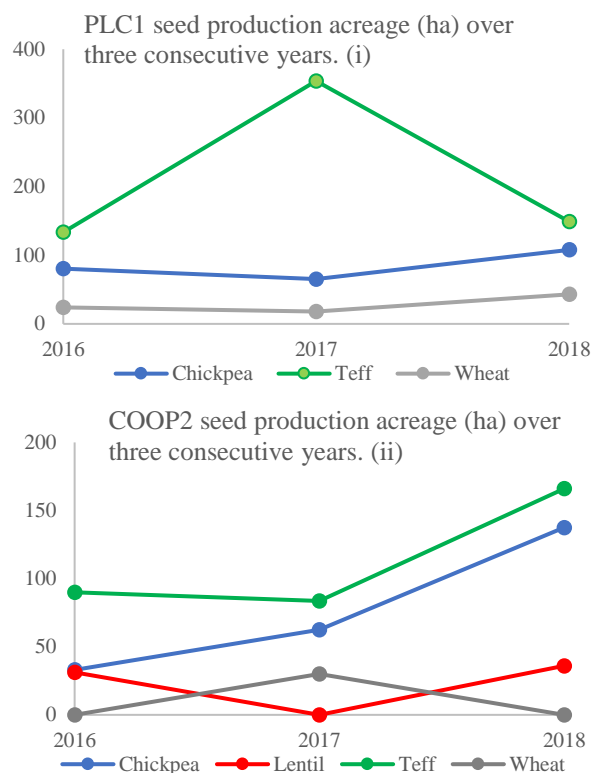


Figure 1. Evolution of seed production hectareage over three consecutive years.

5.4. Business Linkages, Partnerships, Support Organizations and Areas of Support

The seed enterprises have strong linkages with government institutions through the ministries of agriculture and trade, as well as universities and research centers of the Ethiopian Institute of Agricultural Research (Table 4). In addition to public partners, both national and international NGOs and the private sector operators like large seed companies and agro-dealers are supporting the analyzed seed enterprises. While research centers are providing early generation seed and quality seed delivery, the Ministry of Agriculture is empowering the seed enterprises in management and market subjects (Table 5). Financial institutions like the Cooperative Bank of Oromia are backing seed production activities through infrastructural capacity building. International research institutes like the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Center for Agricultural Research in the Dry Areas (ICARDA), and International Maize and Wheat Improvement Center (CIMMYT) are working closely with the seed enterprises through technical capacity building. Syngenta and Fintrac play important roles in promoting the produce, market value chain development and strengthening the overall operation capacity of the seed enterprises.

Table 4. Linkages and business partners of the seed enterprises in Ethiopia in 2018.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Category of partners	<ul style="list-style-type: none"> - Government agencies: Ministry of Agriculture, Universities, Research centers - NGO: International and national NGOs - Farmer organizations: cooperatives - Private agribusiness sector: Agro-dealers, individuals or private farms 	<ul style="list-style-type: none"> - Government agencies: Ministry of Agriculture, Universities, Research centers - NGO: International and national NGOs - Farmer organizations: cooperatives - Private agribusiness sector: Agro-dealers, individual farms 	<ul style="list-style-type: none"> - Government agencies: Ministry of Agriculture, Universities, Research centers - NGO: International and national NGOs - Farmer organizations: cooperatives - Private agribusiness sector: Seed companies, Agro-dealers, individuals and private farms, financial institutions 	<ul style="list-style-type: none"> - Government agencies: Ministry of Agriculture, Universities, Research centers - NGO: International and national NGOs - Farmer organizations: cooperatives - Private agribusiness sector: Seed companies, Agro-dealers, individuals and private farms
Key partners	<ul style="list-style-type: none"> - Debre Zeit ARC/EIAR - Kulumsa ARC/EIAR - The Federal and Oromia Bureau of Agriculture - Ethiopian Seed Enterprise - Syngenta and Fintrac - CIMMYT, ICARDA, ICRISAT 	<ul style="list-style-type: none"> - Debre Zeit ARC/EIAR - The Federal and Oromia Bureau of Agriculture - Ethiopian Seed Enterprise - Syngenta and Fintrac - CIMMYT, ICARDA 	<ul style="list-style-type: none"> - Debre Zeit ARC/EIAR - Kulumsa ARC/EIAR - The Federal and Oromia Bureau of Agriculture - Ethiopian Seed Enterprise - Cooperative Bank of Oromia (CBO) - Agricultural Transformation Agency (ATA) - Agricultural Cooperative Development Institution and Volunteer in Overseas Cooperative Assistance (ACDI-VOCA) - ICRISAT 	<ul style="list-style-type: none"> - Debre Zeit ARC/EIAR - Kulumsa ARC/EIAR - The Federal and Oromia Bureau of Agriculture - Ethiopian Seed Enterprise - ICRISAT
Partnership mechanisms	Direct cash or Contract	Direct cash or Contract	Direct cash or Contract	Direct cash or Contract

EIAR: Ethiopian Institute of Agricultural Research; ARC: Agricultural Research Center; ICRISAT: International Crops Research Institute for the Semi-Arid Tropics; ICARDA: International Center for Agricultural Research in the Dry Areas; CIMMYT: International Maize and Wheat Improvement Center.

Table 5. Analysis of the support mechanisms provided to the seed enterprises in Ethiopia in 2018.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Organizations	Support received			
Ethiopian Institute of Agricultural Research	- Breeder seed supply - Training in quality seed production	- Breeder seed supply - Training in quality seed production	- Breeder seed supply - Training in quality seed production	- Breeder seed supply - Training in quality seed production
Federal and Oromia Bureaus of Agriculture	- Administrative and technical capacity building - Market facilitation	- Administrative and technical capacity building - Market facilitation	- Administrative and technical capacity building - Market facilitation	- Administrative and technical capacity building - Market facilitation
Ethiopian Seed Enterprise	- Supply of foundation seeds	- Supply of foundation seeds	- Supply of foundation seeds	- Supply of foundation seeds
Syngenta and Fintrac	- Market value chain development - Promotion of enterprise's produce - Strengthening overall operations capacity	- Market value chain development - Promotion of enterprise's produce - Strengthening overall operations capacity	-	-
Cooperative Bank of Oromia (CBO), ATA, ACDI -VOCA	-	-	Infrastructural and technical capacity building: seed store, tractor and seed supply	-
- CIMMYT, ICARDA	- Technical support	- Technical support	-	-
ICRISAT	- Technical training	-	- Technical training	- Technical training

5.5. Social and Economic Benefits: Employment and Various Services to the Community

The seed enterprises are already operating as veritable and viable economic entities. Each seed enterprise has secured between 14 and 45 jobs of which at least four are permanent jobs. The job categories involve management, technical assistant, storekeeper, security staff, and daily workers. The estimated annual staff charges vary between USD 3100 and USD 19,000. The private limited companies have a higher operations scope compared to the cooperatives (Table 6).

Table 6. Social economic services to the communities.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Permanent jobs	9	5	4	4
Temporary jobs	36	16	10	15
Profile of staff	Manager, consultant, agronomist, accountant, cashier, foreman, guard, daily laborer	Agronomist, accountant, foreman, guard, daily laborer	Manager, accountant, guard, daily laborer	Tractor operator, manager, guard, daily laborer
Estimated monthly paid staff cost (USD)	19,000	8600	3100	7100

5.6. Main Challenges and Perspectives

The main challenges the seed enterprises are facing revolve around finance, pests and diseases, parent seeds, knowledge, infrastructure (both processing and storage), marketing, land, and weather issues. While financial issues come first for private limited companies, the limited availability of parent seeds was the top challenge for the cooperatives (Table 7). The lack of technologies to limit post-harvest loss is among the top five challenges of the seed enterprises. Across all seed enterprises, seed marketing and distribution remain a major issue.

Table 7. Rankings and weights of the top five main challenges the seed enterprises are facing based on a seven-point Likert scale in Ethiopia in 2018.

Major Challenges	PLC 1	PLC 2	COOP 1	COOP 2
Production	<ul style="list-style-type: none"> - Lack of financial support (7) - Persistent biotic and abiotic stresses (6) - Insufficient availability and access to good quality early generation seed (6) - Lack of varieties and inadequate breeder and pre-basic seed supply for newly released varieties - Inadequate knowledge of seed production and crop management - Poor mechanization - Lack of incentives for early generation seed production - Fragmented fields - Impact of climate change 	<ul style="list-style-type: none"> - Unavailability of credit to invest (7) - Persistent biotic and abiotic stresses (6) - Unavailability of access to good quality early generation seed (6) - Inadequate knowledge of seed production - Poor mechanization - Lack of incentives for early generation seed production - Shortage of land 	<ul style="list-style-type: none"> - Lack of new varieties and inadequate basic seed supply (7) - Internal organization and management (6) - Limited financial capacities to run seed business (6) - Low commitment of members - Limited networks with partners - Limited infrastructure development - Uncertain climate and biotic factors, e.g., unpredictable rainfall, diseases and insect pests 	<ul style="list-style-type: none"> - Limited access to good quality Early Generation Seed (7) - Lack of financial support (6) - Persistent biotic and abiotic stresses - Lack of machinery for planting - Fragmented farmer fields - Unavailability of credit - Surplus production - Limited number of varieties available
Post-harvest (processing and storage)	<ul style="list-style-type: none"> - Lack of seed processing machinery (6) - Limited technical and managerial experience for out-grower farmers - Insufficient store facility - Poor post-harvest handling experiences by out-growers (especially at peak harvest, storage) 	<ul style="list-style-type: none"> - Seed processing machinery (6) - Limited capacity of out-grower farmers - Shortage of store - Post-harvest handling and management 	<ul style="list-style-type: none"> - Limited storage facility (6) - Seed handling at peak of harvest 	<ul style="list-style-type: none"> - Lack of seed processing machinery (6) - Limited post-harvest handling and management experience of members (6) - Mixing of seeds during threshing - Shortage of store
Marketing	<ul style="list-style-type: none"> - Seed marketing and distribution (6) - Absence of promotion - Low quality of seed offered for sale, especially for teff production - Price determination by the government 	<ul style="list-style-type: none"> - Inefficient seed marketing and distribution system (6) - Absence of promotion 	<ul style="list-style-type: none"> - Poor market linkages (6) - Opportunistic behavior and use of alternative market outlets by members 	<ul style="list-style-type: none"> - Inefficient seed marketing and distribution systems (6) - Absence of promotion - Fluctuation of market price

Values in brackets represent the seven-point Likert scale ranking: 1-not important, 2-less important, 3-somewhat important, 4-neutral, 5-moderate, 6-very important, 7-extremely important.

5.7. Perceptions of Support Organizations (Research Institutes, Extension and NGOs) of the Performance of the Seed Enterprises Based on Their Own Defined Criteria

The organizations nurturing the seed enterprises have opined as way of analyzing their performance and the way they see the enterprises in the future. Based on five criteria jointly defined, the seed enterprises were rated on a seven-point Likert scale. They recorded high performance on quality seed production, partnerships, and business linkages, with the private limited companies doing better (6 points) than the cooperatives (5 points). In their opinion, the overall capacity of the seed enterprises required more attention in order to operate as fully independent economic entities (about 4 points) (Table 8).

Table 8. Research institutes, extension and NGO staffs' perceptions of the seed enterprises' performance in Ethiopia in 2018.

Variables	PLC 1	PLC 2	COOP 1	COOP 2
Quality seed production	6	6	5	5
Partnerships and business linkages	6	6	5	5
Overall management structure	5	5	4	4
Effective use of training tools	5	5	5	5
Overall capacity	5	4	4	4

Seven-point Likert scale ranking of seed enterprise performance by support organizations: 1-not good performing, 2-poor performing, 3-somewhat good performing, 4-neutral, 5-moderate performing, 6-very good performing, 7-Excellent performing. Values came from the joint assessment by support organizations.

The disaggregated data from support organizations indicated that research institutes are more optimistic about the seed quality management of private limited companies compared to cooperatives, which face some challenges because of the high number of their members who are essentially smallholder seed producers. Extension services and NGOs reported that extensive and proximity trainings for cooperative members are key to improving their overall management capacity. To make this happen, they suggested more synergetic actions among support organizations for efficient use of the available resources through projects to build independent and well-functioning seed enterprises in the short term.

6. Discussion

The private seed sector development in the sub-Saharan Africa countries has not been well-functioning for decades. As a consequence, farmer access to quality seed of recently released varieties has been very low. This manuscript analyzed the cases of four seed enterprises to understand the path and effectiveness of the support systems they received to become viable seed ventures.

6.1. Incubates and Stage of Incubation

In a wide variety of sectors, incubation has been widely used as a mechanism to support and make viable enterprises at the early stage of their lives [36]. The support systems include incubator space, business support services, clustering and networking opportunities [26,35]. The range of services usually provided to the entrepreneurs includes office space, laboratories, supply store, business planning, marketing, staff training, databases, capital equipment, networking, licensing and intellectual property, and partnership development with other incubates, private and public services [26]. The various support mechanisms provided to the analyzed seed enterprises are well in line with the ones benefiting incubates. The arranged seed production contracts, the technical capacity building on quality seed production, the managerial skills imparted, the value chain development training conducted, the produce promotion brokered are all intended to lay out the foundation for the newly created seed enterprises to survive and grow over time. As most enterprises, seed enterprises are

also economic entities bearing critical charges for their functioning. The area of services provided permit them to significantly improve their survival and growth prospects into fairly viable agri-enterprises [35].

In their current states, the analyzed seed enterprises, both private limited companies and the cooperatives, are still at their early stage. Most importantly, the PLCs are still in need of support from various organizations. If they were to pay for the various capacity developments they need, it would outbalance their current revenue. The main role of agribusiness incubators is to stimulate innovation and new firm entry into business. The support provided tests the hypothesis that new business models can operate profitably and that when complemented by organized value chains, traditional and primary sector production can mature into sustainable wealth and new employment opportunities in rural areas [35]. The analyzed seed enterprises have positively met this hypothesis with all the social and economic opportunities they have created and sustained in the communities.

6.2. Upgrading Seed Business

Making quality seeds available is the biggest challenge to the seed sector for agricultural development in sub-Saharan Africa. Quality seed is expected to possess key attributes such as physical and genetic purity, free from weeds and pests and diseases (fungus, bacteria, viruses, nematodes or insects and mites), high germination, vigorous performance under favorable conditions in the field, conformation to cultivar and possession of an appropriate level of moisture content to avoid any decay in store [51]. For the seed sector to reach this stage, the community seed producers may not be capable enough. The private seed enterprises have a great role to play. This is the reason why, beyond community seed bank and seed production scheme development alone, development organizations implementing seed system interventions should take some steps forward to support upgrading from informal community seed production to formal seed enterprise in a viable way. As in the cases of the analyzed seed enterprises, the avenue to follow is through providing the relevant support systems the informal seed producers need to upgrade to a formal seed enterprise. Formalizing seed production activity into a private seed enterprise has the advantage of increasing quality and sustaining seed delivery to farmers when project interventions end. Though very demanding in terms of follow-up from initiation to maturity, strengthening informal seed producers to upgrade to seed enterprises is the path forward to African seed sector maturity and development. The assets the seed producers develop during their informal period will be a good foundation to uplift them to the next level and grow sustainably [52]. The path will be easy if the idea of upgrading to private seed ventures comes from the seed producers themselves and is nurtured by support organizations in their various capacities and expertise.

6.3. Sustainability of the Incubates

The aptitude of nurtured agribusiness or other forms of enterprises to evolve by themselves and operate independently into a viable business is the key to sustainability. To that effect, the issues around sustainable business development have become some of the major challenges to address nowadays. As a way for new venture development, incubators are generally considered to be one of the key ingredients for lifting local and community social and economic developments. Scholars pointed out four main areas to focus on when it comes to the sustainability of the incubates [53]. These involve (i) the way incubates organize their activities to reach and secure inflow of business, (ii) the influence of external factors, (iii) the specific features that characterize the incubates, and (iv) the kind of supports in which the incubates are embedded. These key areas of sustainability raised [53], are key areas requiring attention to effectively rate the performance of incubates, whether they can endure. The four seed ventures analyzed here have shown their capability to secure business beyond institutional markets. Their efforts to collaborate with existing seed enterprises and secure the markets, the arrays of technical and infrastructural capacity building they receive from various development and research organizations are keeping them in business so far. It is unclear whether they can operate independently if they no longer receive the support they have now. Their ambitions embedded in

their visions, the local and institutional partnerships, and their seed production models are good indications that their businesses are strong enough to resist small shocks in the future. The diversity of crops and varieties they are involved with is also a good predisposition to withstanding shock. The seed production models make use of smallholder seed producers with cropping practices that are environmentally sound, as they make limited use of fertilizer and pesticides. For the growth and development of the seed enterprises analyzed, knowledge has a central role to play. The role of support organizations in the growth and development of the incubates is key as they broker knowledge. Knowledge is a critical ingredient to driving economic growth, and development organizations have a number of mechanisms by which their knowledge is disseminated from its generated environment to the entrepreneurship and innovations systems [54].

6.4. Seed Venture Nurturing and Seed Availability Specifically for Bulky and Self-Pollinated Crops Like Chickpea

The difficulty the seed sector is facing to produce and avail seed of improved varieties for self-pollinated and bulky legume crops, including chickpea and also groundnut, has been widely reported [55]. Farmers usually retain planting material from the previous season's harvest and use it as a source of seed, and inconsistently look for seed for new planting. This does not guarantee the market for seed companies, who fear to invest in such an uncertain market. In such a context, seed companies need some special supports and motivations to secure their investments. Preliminary market arrangements with farmer organizations, secured production contracts with institutional markets (e.g., national and international NGOs, government institutions) are major mechanisms that secure and incentivize seed companies' investments in the production and distribution of bulky and self-pollinated crops like chickpea. The seed enterprises analyzed in this study have such opportunities that support their seed production and marketing activities. The use of out-growers by the private limited companies, or members of cooperatives who are producing seed of improved varieties close to the communities are good mechanisms to introduce more farmers to the seed technologies and open up and expand the seed market. Some of the many initiatives and successes reported by scholars in sub-Saharan Africa [55] deserve to be further strengthened and promoted into formal seed ventures serving farmers with seed of improved varieties of bulky and self-pollinated crops like chickpea and also groundnut.

7. Conclusions

Developing sustainable seed production and delivery models for enhanced farmer access to quality seed of recently released varieties has been the main challenge the seed sector has faced for decades in most sub-Saharan Africa countries. Many models have been developed and tested to reverse the current trend of using farmer-saved and non-improved variety seed. This paper analyzed ongoing experiences in Ethiopia to share learning from current dynamics and inform future initiatives. Informal seed producers have been supported to upgrade to certified and formal seed production and marketing ventures. Through a variety of seed production schemes, the seed enterprises are producing various seed classes that they deliver directly to farmers, institutional markets, and agro-dealers. Both cereals and self-pollinated legume crops are within their crop portfolio. A wide variety of government and development organizations are working closely with the seed ventures to grow into viable and profitable seed entities.

Many project interventions have facilitated so far the initiation and operations of community seed producers in sub-Saharan Africa. For sustainable and reliable seed production and delivery systems, a bold step is needed whereby the informal seed production entities are nurtured and upgraded into formal private seed production ventures that deliver social and economic benefits to the promoters and the communities. Well-embedded in the social economic contexts, the nurtured seed ventures have great opportunities to endure through partnerships and additional support systems from development organizations. Beyond community seed sector development, research and development workers are

encouraged to upgrade some of their initiated informal seed producers into formal, self-running, and profitable seed enterprises to support sustainable seed systems development in sub-Saharan Africa countries. For more than a decade, the Tropical Legumes Project has supported various informal seed entities in countries by crops as part of the project legacy.

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