Ethiop. J. Agric. Sci. 32(2) 71-97 (2022)

Analysis of Seed System Actors: Roles, Responsibilities, and Linkages in Central Ethiopia

Tekeste Kifle[1, 3], Degefa Tolossa[2], Admasu Shibru[3], and Dawit Alemu[4]

[1]Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia; [2] Center for Rural Development, College of Development Studies, Addis Ababa University, Ethiopia; [3]Center for Food Security Studies, College of Development Studies, Addis Ababa University, Ethiopia; [4]Stichting Wageningen Research (SWR) Ethiopia , Wageningen University and Research-WUR, Addis Ababa, Ethiopia; E-mail: tekeste33@gmail.com P.O.Box - 15437, Addis Ababa, Ethiopia

Abstract

A seed system in Ethiopia denotes the entire complex organizational, institutional, and individual procedures related to the development, multiplication, processing, storage, distribution, and sale of seeds. It includes formal, informal, and intermediate seed sectors. The rationale of this paper is how the interests & interactions of the seed actors are related to the performance of the seed system within the formal and informal seed sectors. The study aims to analyze the seed systems actors' roles, responsibilities, linkage, and implications of the gap. The study used qualitative data collected from 25 key informants, and six separate focus group discussants in Ada'a and Bora districts (Oromia region), and Moretena Jiru district (Amhara region). Moreover, secondary data sources were used. The data were analyzed using stakeholder analysis to describe, categorize, narrate, and discuss the seed system actors. The result of the study identified the constraints and gaps of the roles, responsibilities, and linkages of seed system actors related to limited collaboration among the seed actors; limited engagement of the private sector and seed associations during the development of regulatory measures; considerable mismatch in the supply and demand of certified seed of available crop varieties; inefficient seed distribution and marketing mechanisms; weak variety release, seed quality assurance system, and lack of a clear seed policy. The major findings were also that the linkage among seed system actors was very weak due to weak management capacity; lack of coordination between production, processing, and delivery of certified seeds of improved varieties; poor marketing systems; and inappropriate planning & evaluation. This study summarizes the seed system should need further investigation to minimize the constraints and gaps. Coordination and linkages among all actors need strengthening to stand in rapid, orderly, and effective growth. Inter-organizational linkages should be assessed to maintain better aspects negotiate improvements in existing linkage mechanisms and build new relationships among actors.

Keywords: Seed system; Actors; Roles; Linkages; Stakeholder analysis

Introduction

The government of Ethiopia places a high focus on agricultural development to promote overall economic growth, combat poverty, and achieve food security. Agriculture in Ethiopia contributes about 39% of the GDP, generates 90% of the total exports, and provides employment for 80% of the population (CSA, 2013).

Seed is the most vital input for crop production and productivity (Fekadu, 2010). An increase in seed quality can increase the yield potential of the crop by significant folds and thus, it is one of the most economical and efficient inputs to agricultural development. Seed is the most important determinant of crop success or failure, alongside soil fertility and water (Hussien *et al.,* 2013). According to Kassa and Merkine (2020) seed is an essential component and valuable commodity in agriculture, sustained increase in crop production and productivity, and the pillars of farmer's livelihood and food security. One of the important elements of the country's agricultural reform goal has been recognized as the creation of the national seed system. (Abebe *et al.,* 2017). Given the significant current and future role of the agriculture sector, a vibrant seed system that provides quality seed to meet the demands of farmers is an essential facilitator to the continued economic and social development of Ethiopia.

In Ethiopia, the seed system represents the whole complicated structure, institutional, and individual operations related to the development, multiplication, processing, storage, distribution, and promotion of seeds (Fischer and Edmeades, 2010; Abebe and Lijalem, 2011). De Boef et al., (2010) describe A seed system as a collection of dynamic interactions between seed supply and demand that lead to the use of seeds and subsequently plant genetic resources at the farm level. According to FAO (2020), the seed system is the economic and social mechanism by which farmers' demand for seed and other desirable seed traits is met by various sources of supply. A seed system refers to physical, organizational, and institutional components, their actions, and interactions that determine seed conservation, improvement, supply, and use (Teshome, 2021). Different authors classify seed systems into different types: Dawit (2010), and Abebe (2010) explain seed systems classify into formal and informal, while others classify them as local and formal (World Bank, 2015). Louwaars *et al.* (2013) categorized them as farm-saved, community-based, public companies, commercial companies, and closed value chains. In recent years, the idea of an intermediate seed system has appeared in the Ethiopian seed sector and combines both the formal and the informal seed systems (Mohammed and Lemma, 2011). Dejen (2021) noted that the seed system is divided into informal, formal, and alternative seed systems with low quality, quantity, and an intermediate contribution to crop production. A seed system in Ethiopia classifies as a formal, informal, and intermediate seed system (Teshome *et al.,* 2021). Ethiopian Agricultural Transformation Agency (ATA) has recognized the three seed systems in the Ethiopian seed sector: In the "formal" or "commercial" seed sector that the seed of improved varieties is sold to farmers through farmer cooperatives, input suppliers, and other channels; the "traditional" or "informal" seed sector that farmers save seed from their harvest or exchange through social networks for the next planting seasons, gift, borrow, and buy informally; and "intermediate seed systems" imply coordinated actions between

the formal and informal seed sectors (ATA, 2015).

Formal seed system

ATA (2015) describes the formal seed system as a mainly government-supported system and several public institutions are also involved in it. The formal seed system was established with the aim of a dynamic, efficient, well-regulated formal sector that provides farmers with sufficient, affordable, timely, and high-quality certified seeds of improved varieties for key crops through multiple production and distribution channels while maintaining the genetic biodiversity of the country. It is guided by scientific methodologies for plant breeding, multiplication is controlled & operated by public or private sector experts, and significant investments have been made throughout the process (Louwaars and De Boef, 2012). The formal seed system involves public and private sector institutions and a linear series of activities along the seed value chain, including, plant variety development, variety release and registration, quality seed production, and distribution (Louwaars *et al.,* 2013). This system aims to supply adequate amounts of seeds of high quality, at the right time and place, and at reasonable prices. According to Abebe *et al.* (2017), the formal seed systems have been limited by data-based decision making which is demonstrated by the variation and mismatch between seed demand and supplies. Currently, the share of the formal seed system is estimated to be about 10-20 percent of the actual demand of the country and less than 5% of the cultivated area is covered by improved seed (Dejen, 2021). The major actors involved in the formal seed system are the Ministry of Agriculture (MoA), Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs), Higher Learning Institutions (HLIs), Ethiopian Agricultural Business Corporation (EABC), Regional Seed Enterprises (RSEs), Regional Bureau of Agriculture (RBoA), Private Seed Companies (PSCs), Cooperative Unions, and Seed regulatory authorities at federal & regional level.

Informal seed system

The informal seed system involves farmers choosing their seeds, multiplying, storing, using, and distributing them through social seed networks and neighborhood marketplaces. It dominates in terms of delivering large quantities of seeds of a diversity of crop varieties (Coomes *et al.,* 2015; McGuire and Sperling, 2016). The system establishes millions of individual small-scale farmers, who save or exchange seed at the local level and includes development agencies and projects supporting community seed production with no regulatory oversight (Dawit and Zewdie, 2015). Informal seed systems include farmer-saved and exchanged seeds of important food crops, comprising both local and improved varieties that have been accessed through the formal distribution system

(Yohannes *et al.,* 2012). Zewdie (2016) noted it includes both traditional and improved varieties that have been released by the formal system in the past and intermediate into the local seed system. In Ethiopia, the informal system is crucial for the security of seed supply. About 60-70 percent of seed used by smallholder farmers is saved on-farm and exchanged among farmers, and the remaining 20-30 percent is borrowed or purchased locally. ATA (2015) explains the informal seed system accounts for 90 percent of the seed used by smallholder farmers while the share of improved seed is less than 10 percent. The majority of Ethiopian farmers have a predisposition to rely on the informal system because it is currently more affordable and readily accessible in the farmer's villages just at the time seed is needed; allows the use of seeds after testing on primary adopter farmers; and is more reliable and its sustainability is more guaranteed than the formal system (Abebe, 2010). In the informal seed system mainly the Non-Government Organizations (NGOs), farmer organizations, individual smallholder farmers, seed agents, and agro-dealers are the main actors.

Intermediate seed system

The distinction between the formal and informal seed sectors may become somewhat blurred, as farmers may save seeds of better kinds and later regard them to be "local varieties" or “local seed” after some years of usage. In Ethiopia, both the formal and informal seed systems operate simultaneously and sometimes overlap. In addition, there have been attempts made by the government and NGOs to promote quality seed production and distribution through market channels for landrace varieties, although until now the volume they represent is quite small. The newly recognized intermediate seed system has overlapping features with both the formal and informal seed systems. According to Adane *et al.* (2010), the intermediate seed system also includes the production and marketing of seeds by local farmers under financial and technical support from NGOs and breeding centers. The major actors in this system are NGOs and farmers engaged in community-based seed production & marketing.

A sustainable seed system will make sure that high-quality seeds are produced, completely accessible on time, and reasonably priced for farmers and other stakeholders. Extensive research conducted on Ethiopia's seed system, but farmers have not yet been able to fully benefit from the advantages of using quality seed due to inefficient seed production, distribution, and quality assurance systems, as well as bottlenecks caused by a lack of good seed policy on key issues such as access to credit for inputs (Kumulachew, 2015). Seed supply remains limited especially for small-scale farmers; the number of varieties that are suitable for different agro-ecological conditions and farming systems remains limited, shortage of foundation seed for certified seed production, and the varieties are usually low yielding and therefore negatively affect food security (Gebremedhin,

2015). The weak linkage between actors working in agriculture and rural development is one of the challenges of extension services. In addition, the farmers wouldn't tolerate gaining benefits from the new agricultural information that could increase their productivity and output (Teka *et al.,* 2019).

Therefore, due to this limitation, this research attempts to examine these issues more closely. The objective of this study was to analyze the seed systems actors concerning seed policies; to assess the gap in actors' roles and responsibilities, and to identify the factors hindering effective linkage between the actors related to seed production and dissemination in Ethiopia that influence the seed systems by answering the specific question "How the existing seed system and actors are functioning in the study area"?.

Materials and Methods

Study area

The study was conducted in three districts (locally known as *Woreda*). These were *Ada'a* and *Bora* districts from the East *Shewa* zone, *Oromia* region, and *Moretena Jiru* district from North *Shewa* zone, *Amhara* region, Ethiopia. Major crop components of the districts are cereals (tef, wheat, maize, and barley) and pulses (chickpeas, field peas, faba beans, and lentils) grown under rain-fed agriculture. Irrigated horticultural crops are emerging as a new opportunity in the districts.

Method of data collection

In conducting this study a cross-sectional and narrative research design was used. Each primary and secondary sources were accustomed compile the information. Qualitative data were collected from KIIs and FGDs and secondary data sources were used from relevant sources that are, intensive reviews of published and unpublished documents such as peer-reviewed articles, books, dissertations, thesis, and research reports.

Sampling techniques

Multi-stage and purposive sampling technique was used to select two regions, three districts, and two targeted *kebeles* from each district intentionally based on their major crop production and involvement in the seed system. Twenty-five key informants were identified by using the purposive sampling technique and selected from development agents (6), crop & livestock production experts (3), extension agents (3) and Bureau of agriculture heads (1), MoA agricultural input & production marketing experts (1), EABC (1), RSEs (2), ISSD (1), GIZ (1), ATA (1), Seed Association (1), Seed producers (3). All the key informants were having a deep understanding of the seed system and farm experience. Six focus group discussants were organized and selected randomly based on being socially

respected within the society, each group was comprised of 5-7 members with a mix of participants such as DAs, community elders, women-headed households, and farmers in the study area.

Data analysis

The data were generated from KIIs and FGDs and all interviews were transcribed and uploaded into stakeholder analysis software, then categorized, summarized, narrated, and discussed. We employed the stakeholder analysis that is used to understand a system through key actors or stakeholders. It involves two separate steps, identifying actors and their respective roles; and assessing actors' influence and linkages in the system. A systematic policy evaluation was also made on information generated from secondary data sources.

Results and Discussion

The findings of this study were presented and discussed in the subsequent order first, the evolution of the seed system actors and review of policies concerning seed system actors; followed by analyzing the roles and responsibilities gap concerning seed actors; then analyzing the gap of seed actors linkage. Finally presents the conclusions and recommendations.

Evolution of the seed system actors

In Ethiopia, the formal seed system actors started five decades ago as an ad-hoc extension activity by academic and research institutions. In 1942, Jimma Agricultural School was the first to start improved seed production and distribution. As early as 1954, the Alemaya College of Agriculture used to distribute seeds to farmers, and the Institute of Agricultural Research (IAR) followed when it was established in 1966. Later on, the *Chillalo* Agricultural Development Unit (CADU) began to produce and supply seeds to serve farmers in the Arsi region and its surroundings. Meanwhile, in the late sixties and early seventies, many private large-scale commercial farms grew, which were eventually nationalized by the government. The government established new state farms in some parts of the country and farmers' producers' cooperatives were also organized. These developments led to increased demand for modern agricultural inputs, particularly seeds of improved varieties. Improved seed supply was lacking as there was no organized system in the country until the government established the Ethiopian Seed Enterprise (ESE) in 1979. The ESE was initially tasked with providing seeds to the entire farming community through domestic production or imports from other countries. Although its activities were largely skewed to the state farms and cooperatives at the expense of small farmers, then, it has remained the main seed producer and supplier in the formal seed sector.

Moreover, major seed actors or stakeholders were also reconstituted and established into new legal entities through various proclamations and regulations including Ethiopian Seed Enterprise (ESE, proclamation No. 266/1982); National Seed Industry Agency (NSIA, proclamation No. 56/1993); Ethiopian Institute of Agricultural Research, EIAR (proclamation No. 79/1997); Institute of Biodiversity Conservation and Research, IBCR (proclamation No. 120/1998); Ministry of Agriculture and Rural Development, MoARD (proclamation No. 380/2004); Oromia Agricultural Research Institute, OARI (proclamation No. 44/2001); Amhara Regional Agricultural Research Institute, ARARI (proclamation No. 48/2000); South Agricultural Research Institute, SARI (proclamation No. 37/2001); Tigray Agricultural Research Institute, TARI (proclamation No. /2000); Somali Pastoral Agricultural Research Institute, SoPARI (proclamation No. 31/2002); Afar Pastoral Agro-pastoral Research Institute, APARI (proclamation No. /2007); Oromia Seed Enterprise, OSE (regulation No. 108/2008); Amhara Seed Enterprise, ASE (regulation No. 66/2009); South Seed Enterprise, SSE (regulation No. /2010); and Somali Seed Enterprise, SoSE (regulation No. 108/2011). This shows the commitment and interest of the government to strengthening the seed system in the country and all organs dealing with seed regulation, seed production, and seed distribution.

With the gradual move of the country toward a market economy, private seed companies are getting more and more involved in the seed sector. Pioneer Hi-bred Ethiopia, a multinational private company, is the first private seed company that started its operation in the 1990s, following economic reforms. Other private seed producers entered the Ethiopian seed market gradually. Seed producer cooperatives in Ethiopia were recognized as legal institutions in the 1960s during Emperor Haile Selassie's regime (Dawit *et al.*, 2017). During the era of a state-owned economic system (1974–1991), cooperatives were formed and reorganized to facilitate the implementation of collective ownership of properties, which was the government policy, and engaged mainly in the production of industrial crops, such as tea and spices (Bezabih, 2012).

Review of previous and current policies concerning seed system actors

Policies play a major role in shaping the seed sector, particularly as part of the transition to a more market-oriented economy. To guide this process it can be advantageous for countries to have a national seed policy as a declaration determined for their management of the seed sector actors and to provide a stable basis for decision making. The Ethiopian seed industry policy was first formulated in 1992 and serves as the basis for different laws and regulations. The main objectives of this policy were to ensure the plant genetic resources collection, conservation, and evaluation; enhance variety development, release, registration,

and maintenance; develop an effective system for producing and supplying high-quality seeds to satisfy the national seed requirements; encourage the participation of farmers in germplasm conservation as well as in seed production and supply systems; create a functional and efficient organizational setup to facilitate collaborative linkage and coordination in the seed industry; regulate seed quality standards, import and export, seed trade, quarantine, and other seed-related issues. Several proclamations were issued to legally enforce the implementation of the seed industry policy. It included Plant Protection Decree (No. 56/1971); Plant Quarantine Regulation (No. 4/1992); Seed Regulation (No. 16/1997); Seed law Proclamation (No. 206/2000); Plant Breeders' Rights Proclamation (No. 481/2006); and Access to Genetic Resources, Community Knowledge, and Community Rights Proclamation (No. 482/2006) which aimed at creating a legal framework for the protection of the interests and control of the seed actors; designating government agencies which support, advise and control individuals or organizations engaged in the production, processing, import, export, sale, and distribution of quality seeds through the effective and quick supply system.

A systematic literature review was conducted to gather information on seed policy frameworks as well as evidence on the past and current impacts of seed policies on the quality of seeds used by seed system actors in the country. This study reviewed the documents such as a national seed policy, strategy, proclamations, regulations, and directives with substantial implications for seed systems in Ethiopia. Several countries have formal seed policies, with the majority of them based on the seed system development pathway. This path highlights the steps of seed system evolution from traditional farmer-production of seed to a commercially operating seed industry (Louwaars *et.al,* 2013). In Ethiopia, only a few studies have looked at policy aspects of the seed industry, and existing policy has limited a full understanding of the Ethiopian seed sector's difficulties (Mohammed, 2017). Yohannes *et al.* (2012) indicated in their research that seed policy and regulatory frameworks in Ethiopia have been harmonized with rural development policies and strategies. Despite the presence of a seed policy, seed law, and seed standards, its implementation is primarily at the infant stage due to insufficient capacities within regulatory authorities. Kumulachew (2015) noted that in most cases, the policy remains on paper, and several proclamations are being updated ahead of their implementation, seed actors' understanding of these laws and regulations is still quite limited. As indicated by Dawit (2012), Ethiopian seed policymakers are currently striving to modernize and enhance the formal seed system, encouraging the adoption of new seed varieties. Gloria *et al.* (2017) indicated in their study the Ethiopian seed policy provisions have a much larger positive impact on the formal seed sector than on the informal sector. In his findings, 16 percent of coded provisions appear to have negative implications for

the formal seed sector, while 25 percent of provisions appear to have negative impacts on the informal seed sector. The current seed policy strongly promotes agricultural cooperatives to provide smallholders access to the market through collective actions (Dawit *et al.,* 2017).

This study shows that there were net positive effects of policies on both the formal and informal seed sector actors, but the positive effects for the informal sector were dominated by the overpowering positive impacts of seed policies enlarging to the formal sector. This imbalance implies the neglect of informal seed systems during the lack of policy and proclamations implementation. In general, in this study the identified seed policy bottlenecks were the poor implementation of legislation due to lack of awareness among actors; limited engagement of the private sector, seed associations, and other civic societies during the development of regulatory measures; lack of independent and aligned national and regional seed authorities. The results obtained from key informants and focus group discussants indicate that the policies and strategies of the government towards relation were perceived as positive. But the policies and strategies were not usually put into practice as expected. The results also revealed that the constraints of the seed system were lack of a clear seed policy/strategy; inadequate seed marketing information and infrastructure; inefficient extension service; limited collaboration within the seed sector; private companies tend to concentrate on profitable crops; inadequate improved and basic seed supply; lack of effective large scale seed enterprises.

The current seed policy describes how important parties and seed actors contribute to the coordination, organization, operation, and development of the seed system. This policy ensures that the government's vision is adequately reflected in day-to-day operations within the seed sector and it is under revision since 2020. The Seed law Proclamation No. 206/2000 was updated by proclamation No. 782/2013 (It is also under revision in 2021) and covers variety release and registration; seed production and distribution; quality control and assurance, import & export of seed, supply of emergency seed; certificate of competence; seed inspection; and other related issues. It protects farmers through a variety of registration and seed quality controls; to create a level playing field for seed producers by keeping poor-quality seeds from the market. However, it is constrained by insufficient implementation mechanisms and capacity to accommodate the rapidly expanding seed sector development while maintaining the necessary national and international regulatory frameworks. The recent Biosafety proclamation No. 896/2015 and Plant Breeders Right (PBR) proclamation No. 1068/2017 encourage the generation of high-yielding and quality cultivars, a buildup of competitive and innovative breeders, recognizes the rights of farmers to save, use, exchange, and

sell both farm-saved seed and protected varieties, encourage foreign investment, and then provides recognition and economic rewards for those who contribute to the development of high-quality improved varieties. Nonetheless, this proclamation is not operational yet. The absence of regulations, responsible bodies, and guidelines for application and registration mainly hinder the implementation of the PBR proclamation. The seed standards, procedures, and variety of release and registration guidelines are important for seed system actors. There are about 111 items that are currently in use by the Ethiopian standard and these criteria are excessively high as compared to international standards. Producers have not also adhered to the stated requirements in a consistent manner, and there is no agency to enforce implementation. However, these policies, proclamations, and regulations still need to be put into practice, through the establishment of regulatory frameworks.

Therefore, a healthy seed industry is an important component of agricultural development. The Ethiopian seed policy has not been revised for a long time to guide its development and has negative consequences for plant genetic resources conservation, plant breeding research & development, and seed production and distribution system. The seed policy and proclamations are exclusively targeting the formal seed system actors, which ignores the informal seed system actors. As a result, it should be changed and approved to accommodate and encourage the development of both the formal and informal seed sectors, including the establishment of community-based and small-scale seed enterprises.

Gap analysis of the roles and responsibilities of the seed system actors

Structure of the seed system actors

The seed sector in Ethiopia comprises a range of both public and private sectors (Figure 1). The national research system regulated by the Ethiopian Institute of Agriculture Research (EIAR) and embraced by a range of federal research centers, RARIs with regional research centers, EABC, RSEs, and Higher Learning Institutions/ universities (HLIs) is charged with developing improved varieties and materials needed to produce and multiply certified seed advancing sale to farmers. Varietal release, seed certification, and quality control are performed by regulatory authorities such as MoA, RBoA, and district BoA. Seed of improved varieties production and multiplication is carried out by the EABC and RSEs which rely on their farm and to a limited extent bulk up a seed that is given to the local extension and supply system for inputs. The regional system is made up of regional bureaus of agriculture, their district offices, and extension agents working at the *kebele* (the smallest administrative unit of Ethiopia) level. These organizations collaborate closely with private seed companies, seed producer cooperative unions, NGOs, and seed agents & agro-dealers in seed production, distribution, and marketing (ATA, 2015).

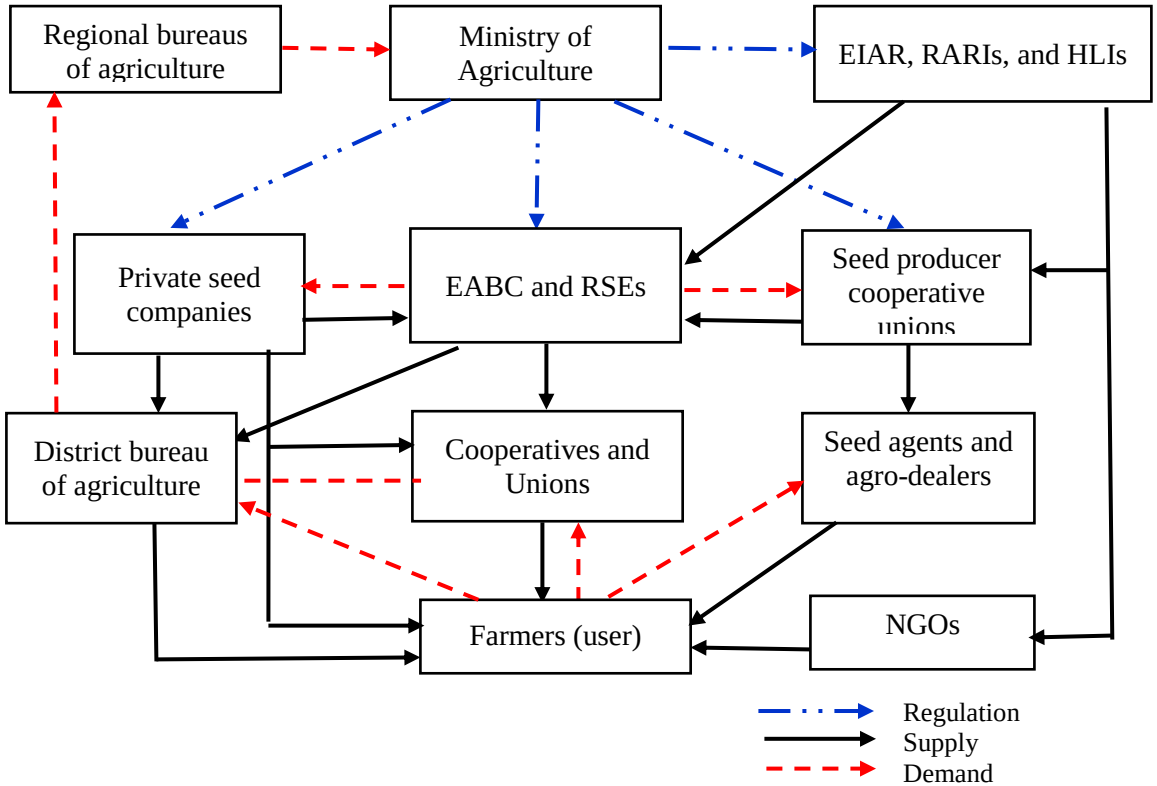

Figure 1: Structure of the Ethiopian seed system actors. *Source: Author's construction*

Several seed actors are involved in promoting sustainable seed businesses in Ethiopia. These actors range from non-market actors to market actors including the Ethiopian Institute for Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs), Institute of Biodiversity Conservation (IBC), Higher Learning Institutions (HLIs), Ethiopian Agricultural Business Corporation (EABC), Regional Seed Enterprises (RSEs), Private seed companies (Pioneer Hybrid Seed Ethiopia), Ministry of Agriculture (MoA), Regional Bureaus of Agriculture (RBoA), district bureau of agriculture, regulatory agencies, Seed Producer Cooperatives Unions (SPCUs), seed agents & agro-dealers, NGOs, and farmers. The roles and responsibilities of these partners vary and sometimes overlap. The review of the document shows that the current rule and regulation has no specific roles and responsibilities mentioned for each actor involved in the linkage either by grouping them in terms of their expected role or as individual actors. The study identified the major challenges of the seed actors such as lack of proper linkage between different actors involved in seed systems; inadequate supply of quality seed at affordable prices; focus on few crops in the formal system; low private sector involvement in the formal system; inefficient seed promotion, distribution, and marketing mechanisms; weak variety release and seed quality assurance system.

Comparison of the roles and responsibilities of the seed system actors:

Research Institutes: the roles and responsibilities of research institutes given by policy and regulation are variety development; early generation seeds (EGS) planning; breeder and pre-basic seed production; demonstration & popularization; researching agricultural issues; provision of information on agricultural technologies; and capacity building & training. EIAR is responsible for the coordination of the national agricultural research system. It undertakes research to generate agricultural technologies relevant to the country as a whole and coordinates different research centers which maintain their autonomous status, and develops extension packages with MoA. RARIs have gradually been appointed to develop varieties suitable for their regions, and conduct targeted research within various geographical identities. IBC is responsible for the conservation of the country's biological resources and plays an important role in the conservation of local germplasm and also in the enhancement of the pool of the existing crop germplasm through the introduction of germplasm from international sources. They maintain a gene bank for the preservation of indigenous varieties, a close partner of the research system in the identification, collection, characterization, and maintenance of improved varieties by providing new genetic material for breeding initiatives. They are also a key collaborator in the identification and management of risks related to biodiversity reduction that is associated with the widespread adoption of improved varieties. HLIs participate in a variety of development, capacity building & training, and conducting quality, relevant and

impact-oriented research. Currently, the research systems actors are doing variety development and evaluation, variety release and verification, demand assessments, early generation seed multiplication, breeder and pre-basic seed production for specific crops, processing, marketing, dissemination, capacity building & training, and conducting research.

Seed regulatory authorities: the role of these actors are variety testing, registration, and release; seed demand planning; emergency seed procurement & supply; seed certification, quarantine, and seed extension; regulatory activities during seed production and marketing; national seed policy & regulatory framework document preparation; input distribution; evaluation & verifications of seed quality inspection laboratory (SQIL); quality declared seed assurance; experience sharing to other farmers, demonstration & popularization. The responsibilities of MoA are developing the national agricultural policies & strategies, coordinating policy implementation across regions, and overseeing the distribution of inputs. The ministry focused on variety registration and release, seed import/export, seed quality control, seed distribution and certification, quarantine, and extension. The regulatory directorate under MoA is expected to provide technical support to the regions on seed quality assurance. They are also in charge of mediating disputes between local state regulatory agencies and seed producers. At the federal level, regulatory services are provided by two directorates. The role of the plant variety release, protection & seed quality control directorate is to provide seed laboratory services under its support and to serve as a reference laboratory and arbitrator for disputes between seed producers and laboratories in the regional states. While the plant health & quality control directorate focuses on the quarantine of seeds moving across the national border. At the regional level, seed regulatory services are provided by semi-autonomous authorities operating under the technical supervision of the BoAs. They are not only responsible for seeds, but also other agricultural inputs. Currently, the seed regulatory authorities acted on variety release and registration, providing and protecting plant breeder rights, phytosanitary services, assuring seed quality, and issuing certificates of competence to seed businesses. Actors are engaged in the assurance of the release of superior improved varieties with distinct characteristics, in the provision of the certificate of competence for seed production and agro-dealers, in EGS seed quality control and assurance, and in quality assurance of certified seed production. These also follow both internal and external quality control systems (Mandefro *et al.,* 2020).

Public seed enterprises: these actors focus on the production, distribution & marketing of certified seeds of improved varieties; farmer-based seed production, distribution, and sales; farm area selection & clustering; contract seed

multiplication; demonstration & follow up on seed production; determine the prices of all seed classes; and demand assessment. The role of EABC (former ESE) has been multiplying and distributing certified seeds of improved varieties for major crops of cereals and pulses and dominating the formal seed system market. RSEs are the sole public seed enterprise and the main tasks are to multiply and distribute certified seeds of improved varieties of major crops to satisfy the regional seed demand. Currently, they are doing on producing and supplying large volumes of certified seeds to the country. But, they focus only on a few crops (hybrid maize, bread wheat, tef, and barley) and do not have much attention and technical, facility and finance capacity in investing in crops/varieties demanded by markets.

Private seed companies: the roles and responsibilities of these actors are demand planning; variety testing; production, processing, and marketing of hybrid maize seed; engaging in certified & basic seed production; contractual seed multiplication; involvement in research and development activities; agricultural input provision and demonstration. The government policy encourages the involvement of the private sector in agricultural intensification in areas of variety development, seed production, and marketing. Currently, their role is in the multiplication and distribution of seeds. Some produce seeds on their farms and others under a contractual framework with individuals or groups of farmers.

Seed producer cooperatives & unions (SPCUs): the given tasks are multiplying seeds, distributing agricultural inputs, providing marketing services, emergency seed procurement, engaging in basic seed production, and demonstrating pre-scaling up. Currently, the roles of SPCUs are to produce and market quality seed to local markets and beyond, to make seed a commercial product, and thus to generate income and improve the livelihood of their members. These multipurpose cooperatives are to help members to get the required inputs (seeds and fertilizers), negotiate seed prices with contracting parties (seed companies), and to access training and technical support in seed production and marketing.

Seed agents and agro-dealers: the role of these actors are to sell seed to farmers on behalf of seed producers the seeds are sold at a fixed producer price and the commission is based on the amount sold. To supply agricultural input in rural areas at a retail price including seed, and related information on input performance across different contexts. They have the potential in supporting farmers' decisions on input purchases and have described the constraints they face to expand and consolidate their businesses. At present, they offer a strategic entry point for interventions to accelerate varietal turnover in the seed sector and interactions between seed companies, seed retailers, and farmers. Sell seed and provide

technical assistance to farmers on seed selection.

Non-governmental organizations (NGOs): involved in emergency seed supply; participation in joint research trials; organizing farmers' groups and seed producer cooperatives by coordinating with the cooperative promotion offices of the government. Improve the capacities of farmers' groups for producing and marketing seed, by organizing training and donating post-harvest technologies, such as seed cleaning machines, funding linkage platforms where farmers and other actors raise development problems; capacity development & training; farmer-based seed production. Currently, they focus on intermediary seed systems with a community-based and local seed business approach. It supports the establishment of primary cooperatives and unions for achieving local seed security and consequently attaining food security. Others support establishing community seed banks and providing emergency or relief seeds.

Farmers: participating in the process of problem identification, and rural development; engaged in certified and farmers-based seed production; provision of clustering fields for seed multiplication; participating in demonstration & pre-scaling up; sharing information/knowledge with different stakeholders concerning agricultural technology development and extension service; demanding certified seeds of improved varieties. Currently, farmers depend on locally selected and saved seeds alongside farmer-to-farmer seed exchanges. Participate in seed production, procure, save, exchange, and sell seeds as farmer-led seed systems and adoption of improved varieties and other agro-inputs.

Gaps the roles and responsibilities of seed system actors

Research system (EIAR, RARIs, HLIs): the gap in the research institutes was a limited variety of development and adaptation specific to the district agro-ecology; lack of providing extension and training for DAs and lead farmers to increase awareness on varietal information and agronomic practices; variety replacement rate is low due to slow release of new varieties and low seed multiplication of released varieties; limited availability of EGS in quantity; the disparity between the amount of breeder seed delivered to the formal seed system and the amount of certified seed; lack of clear institutional arrangements and system setting; inconsistent demand for EGS; lack of commercial concept into seed units of the research system and limited capacity.

Seed regulatory authorities (MoA, RBoA, District BoA, and RQCAA): lack of demand assessment system; lack of an independent body for variety release and registration; limited involvement of public and private seed producers, farmers, and agro-processers in NVRC; inadequate human resources to conduct field inspection at all seed production stages; limited laboratory facilities and testing

protocols to conduct quality tests of all seeds from producers' plots contributing to ineffective seed certification; lack of training provided on seed production and infrastructure support for individual households and cooperatives to increase the capacity seeds that they obtain from public seed companies should be stored correctly.

Public seed enterprises (EABC, RSEs): focus on limited crops and varieties; absence of internal quality control system and limited facilities; sometimes, wrong varieties are distributed in wrong agro-ecological areas; lack of early generation seeds production due to limitations in crop adaptation; limited price incentives for certified seed producers, weak seed demand for non-commercial food security crops, and lack of seed promotion in non-commercial crops.

Private seed companies: limited to the production of hybrid maize seed and sale; lack of opportunity to participate in the development of varieties; lack of expertise and appropriate varietal release mechanism, and low linkage of the informal sector to the variety release activities.

Seed producer cooperatives & unions: distribute untraceable poor-quality seeds due to lack of accountability and transparency in the conventional seed distribution system; distributes seeds of improved varieties to areas for which there is no demand or to the wrong agro-ecologies; do not participate in seed demand assessment, and depend on unrealistic data collected by extension agents and wrong quota allocation.

Non-governmental organizations (NGOs): lack of training provided on crop diversification often promotes traditional varieties as better varieties than improved varieties.

Seed agents and agro-dealers: seed sold at local markets is generally rated by farmers as poor in terms of germination and purity; lack of good storage facility for temporary stocking until they sell seeds or return leftover seeds, which sometimes affects quality.

Farmers: lack of sources of new disease-resistant varieties; difficulty in assessing the physical or genetic qualities of seeds before they are planted; they do not save their seeds to meet their needs mostly depend on the local exchange or purchase of recycled seeds of improved varieties; lack of good storage facility cause damages in household seed stocks.

Implications of the gap analysis roles and responsibilities

Research Institutions (EIAR, RARIs, and HLIs): ensure all EGS producers have internal quality control systems and enforce all producers to have certification by

external seed certification agency and capacitating knowledge on maintenance breeding modernization of national capacity to ensure testing of varietal genetic purity using advanced methods like DNA fingerprinting techniques. The need for the clarity of mandate and responsibility for the production of EGS among actors and to manage the issue of demand creation with a clear role and responsibility for EGS and certified seed producers. Semi-commercialize the EGS multiplication and delivery system in the public research institutes could be established. The government needs to recognize the private sectors as key role players in a variety of development, so it should provide support to strengthen its capacity. Reconsider and redesign the EGS production scheme including decentralization and variety licensing.

Seed regulatory authorities (MoA, RBoA, District BoA, and RQCAA): the need to reconsider the role of the public sector in the demand assessment and shift more to the regulatory aspect, and ensuring the demand assessment is the responsibility of the seed producers themselves along with the risk of marketing. It is imperative to have an independent national body to handle variety release and registration, with full capacity and authority, and a need to broaden members of the variety release committee by including the stakeholders. Established a system for creating independent certifying authorities that could support increasing the availability of quality seeds. Laboratories should be accredited based on ISTA standards that would facilitate seed harmonization largely among the neighboring countries to export and import seeds.

Public seed enterprises (EABC, RSEs): establishing internal quality laboratories would minimize the delivery of poor quality seed and the expected internal check and balance services for the certified seed produced by the seed producer organization itself. This implies the need to ensure traceability, accountability, and transparency as well as competitiveness in terms of price, quality, and brand support for seed producers. Need to revisit the extension system that can deliver the full package of seed promotion and capacitate the farmers in terms of skill and knowledge which creates a huge demand for improved seeds. Establish incentive mechanisms to increase participation of cooperative unions, seed producer cooperatives, agents/agro-dealers, and local private sectors in the seed industry.

Private seed companies: a need to support participation in research and crop improvement, variety development, and variety release activities.

Seed producer cooperatives & unions: need to assess their seed demands directly from the farmers and recruit professional cooperative managers and considered agronomists. The necessity to develop a system of traceability and accountability.

Non-governmental organizations (NGOs): develop guidelines that can support cooperatives and unions through capacity building. Needs enhancing crop diversification, and strengthening the rural infrastructural development.

Seed agents and agro-dealers: a need to incentivize retailers working in seed marketing, especially in remote areas, capacitate the dealers that would improve access to inputs to farmers, and need to standardize the seed store.

Farmers: the need to involve in farmers' research and extension groups in participatory variety evaluation, on-farm demonstration, and promotion of the newly released variety that would help to avail preferred varieties by farmers. The need to establish a seed reserve system with standard storage facilities across the country.

Gap analysis of the seed actors' linkage

The analysis of linkage interactions among actors and institutions is based on the roles & responsibilities in the seed system that allow the exchange or transfer of information, resources, and power, mechanisms that can be structural or functional by the social network approach. Coordination and linkage among actors in the seed value chain play a very crucial role to enhance the efficiency of seed production and marketing. To play various roles in the chain, multi-stakeholders should take part as operators, supporters, and enablers (Habtamu *et al.*, 2019). Linkages between the seed actors are widely recognized as essential for an effective flow of technology and information. The types and nature of the linkage between actors are directly influencing the production and productivity of smallholder farmers. It is commonly recognized by stakeholders that poor performance of the seed system is often related to linkage problems (Shimelis, 2012).

Technical linkage within the seed system actors'

The research institutions conduct adaptation trials in collaboration with the district bureau of agriculture on farmers' plots to ensure suitability to farmers' environmental and socioeconomic conditions; produce EGS and make these available for public seed enterprises, unions, and SPCs; conduct internal quality control of its EGS before distribution to other actors for adaptation trial and multiplication; supports field demonstration and extension to increase awareness of farmers and development agents on varietal information and good agronomic practices, and provides training in the post and pre-harvest technologies. According to Karta *et al.* (2021), the existence of strong early generation seed schemes at research centers and with other actors is essential for sustaining crop productivity. Provide technical expertise to seed companies for the production of quality inputs & research on agricultural issues.

The seed regulatory authorities provide technical training on quality seed production, processing, and storage for internal seed quality control for seed producer cooperatives and farmers. The district bureau of agriculture brings pre-basic/basic seeds or early generation seeds (EGS) of improved varieties from research institutes located in similar agro-ecology and conducts participatory variety trials together with farmers under different input packages and agronomic practices; assesses farmers' seed demand and determine the number of certified seeds required; provide external support for formally organized farmers for seed production and distribution in collaboration with cooperative unions promotion office; support market-led seed supply to increase the availability of certified seeds and locally produced quality declared seeds (QDS) in collaboration with the regional bureau of agriculture.

The public seed enterprises produce certified seeds & EGS and supply through MoA distribution channels. They train contract cluster groups and members of SPCs in quality seed production and management as well as agronomic practices; produce certified seed through contract arrangement on public and private commercial farms and on farmers' fields along with the production on their farms; provide training to participating farmers along with area selection and clustering. The regional seed enterprises and private seed growers are using seed laboratories of their respective regions, neighboring regions, or EABC laboratories for quality assurance, cleaning, and labeling of their seeds.

The private seed companies produce seeds on their farms and under a contractual framework with individuals or groups of farmers and combine their efforts to produce and supply seed to the growers, share information on their activities and learn from other actors.

The seed producer cooperatives & unions (SPCUs) support farmers in the provision of basic and certified seeds, training, and supervision through linking farmers with research institutions and input service providers; procures certified seeds from public seed enterprises and private seed companies to deliver to farmers; engaged in seed production of open pollinating varieties with technical support from district BoA.

The non-governmental organizations (NGOs) link between researcher and beneficiaries, partner for need-based research program; provides financial, technical, and administrative support to increase the number and capacity of SPCs and seed agents for the production and distribution of large quantities of crop varieties; disseminating knowledge, advisory services, and provide training to

farmers and SPC members on clustering, isolation, and field management.

The seed agents and agro-dealers share knowledge of the quality and quantity required for input generation; supply of inputs, marketing, and sale of agricultural inputs in collaboration with farmers and SPCUs. Farmers' linkage is to verify the varietal suitability of seed accessed through social networks and seed agents; share information/knowledge and experience with other farmers; identification of field problems with other actors; participate in the preparation of action plan with extension agents and district bureau of agriculture.

Seed actors' linkage gaps

The identified seed system actors' linkage gaps were a lack of coordination between production, processing, and delivery of certified seeds of improved varieties; limited EGS of improved varieties provide to the district bureau of agriculture for use in participatory trials, but most of them failed to adapt to the local environment; insufficient quantities of certified seeds and EGS supply by the public seed enterprises and distribution is often delayed; distribute varieties that are not recommended for the specific agro-ecology (e.g., hybrid maize for highland is sold to midland areas). Actors did not establish seed reserves for seed system resilience in cases of disaster; inconsistent and inaccurate demand planning; productivity gaps and financial constraints in their contract grower schemes; lack of diverse and good quality varieties as well as limited quality assurance mechanisms.

Implications of the gap analysis of seed actors' linkage

Collaborative institutional linkages need to be promoted among all actors to strengthen the seed system of the country. Create dialogue-based relations with farmers to enable them to express what desirable technologies are for them in their particular context. Improve the operational effectiveness of public seed enterprises, such as through improved assessments of farmer demand and revised seed production strategies. A favorable policy environment needs to be established to encourage and enable innovations by seed actors. Thus, system perspectives with transparent and agreed-upon linkage policies based on the consent of the seed actors should be a prerequisite for vibrant and integrated seed sector development. Joint visions and regular multi-stakeholder discussions are needed between the range of actors and interest groups that result in joint analysis, planning, and hence collective action. Improving the performance of seed producers' interaction between seed sector actors, and the factors that affect the individual performance of the different actors themselves.

Actors Linkage Map

The linkage of each actor with the other actors of the seed system is shown as per the seed actor linkage map (Figure 2). The major actors were the Ministry of Agriculture (MoA), Ethiopian Institute of agricultural research (EIAR), Regional

agricultural research institutes (RARIs), Higher learning institutions (HLIs), Ethiopian agricultural business corporation (EABC), Regional seed enterprises (RSEs), Private seed companies (PSCs), Regional Bureau of agriculture (RBoA), District BoA, Regional quality control assurance agency (RQCAA), Seed producer cooperative unions (SPCUs), NGOs, Seed agents & Agro- dealers, and Farmers. The actor linkage map depicts the connections between the various actors involved in the seed system in the study area. In this map linkages among the actors are expressed as strong, medium, weak, and no linkage based on actors' perception of the transparency, credibility, complexity, intensity of collaboration, rules, and regulations in their roles & responsibilities as a part of the seed system (Demekech *et al.,* 2010). Key informants and focus groups determine how they are linked to one another through the power of linkage, extension service, input distribution, provision of agricultural technology, administrative and technical support, knowledge sharing, training, and market link.

The identified seed system actors at the national level linked strongly MoA with EIAR, EABC, RBoA, and RQCAA; EIAR with MoA, RARIs, HLIs, EABC, DBoA, and RQCAA; RARIs and EABC with RSEs and RQCAA; RSEs with RBoA, RQCAA, and DBOA; PSCs & cooperative unions with Farmers; PSCs with DBoA; SPCUs with cooperative unions & Farmers; DBoA with Farmers, SPCUs, Cooperative unions, NGOs, Seed agents & agro-dealers; RBoA with RQCAA, DBoA, and cooperative unions; seed agents & agro-dealers with Farmers, SPCUs, and cooperative unions. There is a medium linkage between MoA with DBoA, PSCs, SPCUs, & cooperative unions; EIAR with RSEs, RBoA, PSCs, farmers, and NGOs; EABC with Farmers, Seed agents & agro-dealers, DBoA, SPCUs; RSEs with cooperative unions & seed agents & agro-dealers; PSCs with RBoA; NGOs with Farmers; SPCUs with NGOs; RQCAA with cooperative unions and DBoA; RARIs with RBoA and DBoA; RBoA with SPCUs and Farmers. The weak linkage between MoA with RARIs, HLIs, RSEs, NGOs, and Farmers; EIAR with cooperative unions and SPCUs; RARIs with EABC, PSCs, cooperative unions, NGOs, Farmers, and SPCUs; EABC with RBoA; RSEs with PSCs, SPCUs, and Farmers; PSCs with RBoA, cooperative unions, Farmers, SPCUs, and seed agents & agro-dealers; HLIs with RBoA, cooperative unions, and SPCUs; EIAR with SPCUs; RQCAA with NGOs, SPCUs, and Farmers. The result also indicates no linkage between HLIs with EABC, RSEs, DBoA, PSCs, seed agents & agro-dealers, and Farmers; EABC with PSCs, cooperative unions, and NGOs; RSEs with NGOs and Farmers; PSCs with NGOs and RQCAA; MoA, EIAR, RBoA, RQCAA, and NGOs with seed agents & agro-dealers (Figure, 2).

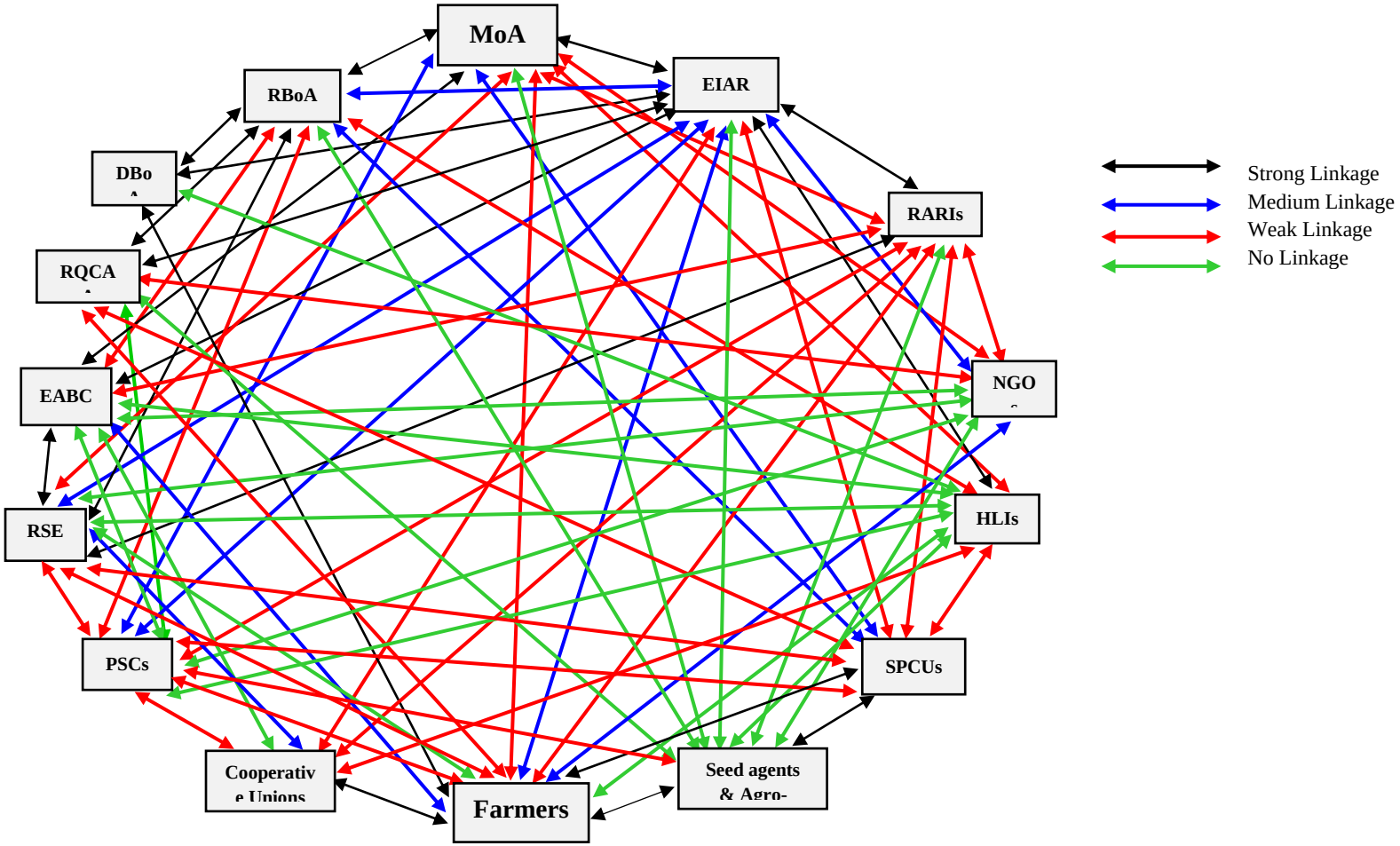

Figure 2: Linkage of seed system actors.

Source: Field survey, 2021

The result showed that 34 percent of the linkages among actors were weak, 29 percent were strong, 20 percent medium, and 17 percent had no linkage. The reasons for weak linkage were poor management capacity; inappropriate organizational structure; unfavorable reward systems; time and money constraints; inappropriate planning, monitoring, and evaluation of the process of interaction; different organizational cultures, expectations, and operating procedures; lack of integration among actors; poor marketing system; and poor seed multiplication schemes. All of the identified actors have roles and responsibilities that are interrelated. The inefficiency of one actor has an automatic detrimental impact on the performances of the other performers. The key informants also stated that there is a lack of commitment, coordinated planning, poor communication between linkage partners, and implementation in the linkage of different actors.

Therefore, coordination and linkages need strengthening to substitute rapid, orderly, and effective growth. Inter-organizational linkages should be assessed to maintain better aspects negotiate improvements in existing linkages, and linkage mechanisms, and build new relationships among actors.

Conclusion and Recommendations

The Ethiopian seed system has been confronted with several constraints. Some of the identified constraints of the seed system were lack of a clear seed policy/strategy; inadequate seed marketing information and infrastructure; inefficient extension service; inadequate improved seed supply; lack of proper linkage between different actors involved in seed systems; focus on few crops in the formal system; low private sector involvement in the formal system; inefficient seed promotion, distribution, and marketing mechanisms; weak variety release and seed quality assurance system. In Ethiopia, the formal seed sector, which includes both public and private companies' supplies about 10-20% of the actual demand of the country, while improved seed covers less than 10% of the cultivated area. The informal seed system accounted for about 80-90% of the local seed used by smallholder farmers.

The seed system requires more investigation with full utilization, collaboration, and dedicated responsibilities and should be given attention to effective seed demand assessment mechanisms and seed system planning. Seed system strategy should be properly prepared in terms of quality, time and place of supply, and fair pricing; fill the huge gap between seed demand and supply; establish clear and simple institutional and functional linkages between research and seed-producing institutions.

The Ethiopian seed policy has not been revised for a long time to guide its development. This has negative consequences for plant genetic resources conservation, plant breeding research & development, as well as seed production and distribution system. The existing national seed policy, seed law proclamation, and seed regulation articles and provisions should be reviewed and updated to support and encourage the development of formal and informal seed systems, as well as small-scale farmers and cooperatives.

To simplify the roles and responsibilities gap among existing seed actors in the sector, and resolve any issues that arise, a joint vision and development program should be developed between the research institutes, public sector producers, private seed companies, cooperatives, and farmers along with a regular discussion forum to highlight and mitigate any issues.

Weak coordination and linkages were observed among seed actors for seed production, distribution, and marketing due to weak management capacity; inappropriate organizational structure; inappropriate planning; lack of integration among actors; lack of accountability and responsibility were the main challenges observed to enhance the efficiency of the seed sector. So, coordination and linkages among seed actors should need to strengthen to stand in rapid, orderly, and effective growth; create a mechanism to strengthen their linkage in the seed system.

Acknowledgments

We would like to thank the Ethiopian Institute of Agricultural Research (EIAR), Agricultural Growth Project (AGP-II), and Addis Ababa University for their financial support for this research. We are grateful to the participants of key informants, focus group discussants, enumerators, and household respondents who provided the necessary information in the study area.

References

Abebe Atilaw. 2010. A baseline survey on the Ethiopian seed sector. The African seed trade association. Addis Ababa, Ethiopia.

Abebe Atilaw and Lijalem Korbu. 2011. Recent development in seed systems of Ethiopia. Improving farmers' access to seeds empowers farmers' innovation. Series No. 1, edited by Alemu D, Kiyoshi S, and Kirub A, 13–30. Addis Ababa, Ethiopia: JICA

Abebe Atilaw, Dawit Alemu, Zewdie Bishaw, Tekeste Kifle, and Karta Kaske. 2017. Early Generation Seed Production and Supply in Ethiopia: Status, Challenges, and Opportunities. Ethiopian Journal of Agricultural Science.

27(1): 99-119.

Adane Hirpa, Meuwissen M, Agajie Tesfaye, Lommen W, Oude A, Admasu Tsegaye, and Struik P. 2010. Analysis of seed potato systems in Ethiopia. American Journal of Potato Research. 87:537–52. Doi: 10.1007

ATA. 2015. Seed system development strategy: Vision, systemic challenges, and prioritized interventions. Agricultural Transformation Agency. Working strategy document, Addis Ababa, Ethiopia.

Bezabih Emana. 2012. The cooperative movement in Ethiopia. Paper presented in a workshop on perspectives for cooperatives in Eastern Africa, 2–3, October 2012, Uganda

Coomes O, McGuire S, Garine E, Caillon S, McKey D, and Demeulenaere E. 2015. Do farmer seed networks make a limited contribution to agriculture? Four common fallacies. Food Policy. 56:41–50.

CSA. 2013. Living standards measurement study intermediate surveys of agriculture. Ethiopia socio-economic survey. Federal Democratic Republic of Ethiopia, Central Statistical Agency, Addis Ababa, Ethiopia.

Dawit Alemu. 2010. Seed system potential in Ethiopia: Constraints and opportunities for enhancing the seed sector. International Food Policy Research Institute.

Dawit Alemu. 2012. The Political Economy of Ethiopian Cereal Seed Systems: State Control, Market Liberalization, and Decentralization. Future Agricultures Consortium. Policy Brief. 048.

Dawit Alemu, and Zewdie Bishaw. 2015. Commercial behaviors of smallholder farmers in wheat seed use and its implication for demand assessment in Ethiopia. Development in Practice. 25(6):798–814. doi:10.1080/09614524.2015.1062469

Dawit Tsegaye, Frans JHMV, and Hans CMT. 2017. Seed producer cooperatives in the Ethiopian seed sector and their role in seed supply improvement: A review. Journal of Crop Improvement. 31(3): 323-355. DOI: 10.1080/15427528.2017.1303800

De Boef W, Dempewolf H, Byakweli J, and Engels J. 2010. Integrating genetic resource conservation and sustainable development into strategies to increase the robustness of seed systems. Journal of Sustainable Agriculture. 34:504–531. DOI: 10.1080/10440046.2010.484689

Dejen Bekis. 2021. Status of Seed System in Ethiopia. Journal of Advances Crop Science and Technology. 9:4. ISSN: 2329-6879.

Demekech Gera, Fisseha Moges, Getnet Zeleke, Kindie Tesfaye, and Melkamu Ayalew. 2010. Multi-stakeholder linkages in rural innovation processes in Amhara region, Ethiopia. Amhara National Regional State, BoARD. Working Document Series 137.

FAO. 2020. National Community Seed Bank Platform for Strengthening Informal Seed System in Ethiopia. Benefit Sharing Fund Project – 4th Cycle. Food and Agriculture Organization of the United Nations.

Fekadu Beyene. 2010. The role of NGO in informal seed production and dissemination: The case of eastern Ethiopia. Journal of Agriculture and Rural Development in the Tropics and Subtropics. 111(2): 79-88.

Fischer R, and Edmeades G. 2010. Breeding and Cereal Yield Progress. Journal of Crop Science Society of America. 50:85-98. DOI: 10.2135. | 677 S. Segoe Rd., Madison, WI 53711 USA.

Gebremedhin Welu. 2015. Challenges and Opportunities of Seed Multiplication in Eastern Tigray Ethiopia. Journal of Biology, Agriculture and Healthcare. 5(3):42. ISSN 2224-3208.

Gloria A, Travis W, Altinay K, and Isabel L. 2017. Implications of Seed Policies for On-Farm Agro Biodiversity in Ethiopia and Uganda. Journal of Sustainable Agricultural Research. 6(4): ISSN 1927- 050X E-ISSN 1927-0518

Habtamu Diriba, Dandena Gelmesa, Kemal Kasim. 2019. Prospects and Challenges in Seed Sector Development: Lessons from Eastern Ethiopia. European Business & Management. 5(4):51-63.

Hussien Mohammed, Tadesse Dessalegn, Fetien Abay, and Thijssen MH. 2013. Participatory varietal selection for enhancing farmers' access to quality seed in Ethiopia. In Community Biodiversity Management-promoting resilience and the conservation of plant genetic resources, 279–84. New York, USA.

Karta Kaske, Astawus Esatu, and Abebe Atilaw. 2021. The interface of demands for certified seed and supplies of early generation seed in major food crops in Ethiopia: Challenges and ways forward. In: Karta Kaske, Taye Tadesse, Sofiya Kasa, and Driba Geleti. (Eds), Early Generation Seed Production in Ethiopia: Trends and Way Forward. Proceedings of a 1st consultative workshop, August 3-4, EIAR.

Kassa Tarekegn and Merkine Mogiso. 2020. Assessment of improved crop seed utilization status in selected districts of Southwestern Ethiopia. Journal of Cogent Food and Agriculture. 6:1. DOI: 10.1080/23311932.2020.1816252

Kumlachew Alemu. 2015. Seed Production and Dissemination Systems Analysis: The Case of Ethiopia. Journal of Food Science and Quality Management. IISTE. ISSN 2224-6088. Vol.35.

Louwaars N, and De Boef W. 2012. Intermediate seed sector development in Africa: A conceptual framework for creating coherence between practices, programs, and policies. Journal of Crop Improvement. 26:39-59. doi:10.1080/15427528.2011.611277.

Louwaars N, De Boef W, and Edeme J. 2013. Intermediate seed sector development in Africa: A basis for seed policy and law. Journal of Crop Improvement. 27:186–214.

Mandefro Nigussie, Karta Kaske, Amsalu Ayana, Dawit Alemu, Mohammed Hassena, Tefera Zeray, Abeneazer Adam, and Amsale Mengistu. 2020. Status of Seed Quality Control and Assurance in Ethiopia: Required Measures for Improved Performance. EIAR. ISBN: 978-99944-66-52-8.

McGuire S, and Sperling L. 2016. Seed systems smallholder farmers use. Food Security. 8:179–195. DOI: 10.1007/s12571-015-0528-8

Mohammed Hassena. 2017. The seed for change: the making and implementation of seed policies in Ethiopia. Ph.D. thesis, Wageningen University, the Netherlands. ISBN: 978-94-6343-668-7 DOI: 10.18174/421204

Mohammed Hassena, and Lemma Dessalegn. 2011. Assessment of the Ethiopian Seed Sector. Paper presented at the African Seed and Biotechnology Program Workshop, May 2011, Addis Ababa.

Shimelis Atalay. 2012. Analysis of research-extension-farmer linkage in finger millet technology development and delivery in Mecha district of Amhara Region, Ethiopia. Journal of Agricultural Economics and Development. 1(6):121-129.

Teka Debele, Mulugeta Gebeyehu, and Alemayehu Abebe. 2019. Contributions and Challenges in Research and Extension Linkage for Agricultural Transformation in Ethiopia. International Journal of Agricultural Extension. 7(2):187-195. DOI: 10.33687/ijae.007.02.2971

Teshome Hunduma. 2021. Politics of Seed in Ethiopia's Agricultural Transformation: Pathways to Seed System Development. Journal of Frontiers in Sustainable Food System. 5:742001. DOI: 10.3389.

Teshome Hunduma, Dalle SP, Makate C, Haug R, and Westengen O. 2021. Pluralistic Seed System Development: A Path to Seed Security? Agronomy. 11: 372. https://doi.org/10.3390/

World Bank. 2015. Enabling the Business of Agriculture: Progress Report. Strengthening the Seed System. The World Bank.

Yohannes Tesfaye, Amsalu Ayana, and Gareth B. 2012. Ethiopia Seed Sector Assessment. ISSD Briefing Note September 2012**.** Wageningen University and Research center, Wageningen, the Netherlands.

Zewdie Bishaw. 2016. Rapid deployment of rust-resistant wheat varieties: ICARDA's experience and lessons learned. In Containing the Menace of Wheat Rusts: Institutional Interventions and Impacts; Zewdie Bishaw, Dawit Alemu, Abebe Atilaw, Abebe Kirub Eds.; Ethiopian Institute of Agricultural Research: Addis Ababa, Ethiopia, pp. 1–40