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Enhancing Access and Adoption of Improved Seed for Food Security of Ethiopia (A Review)

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Abstract
Increasing agricultural productivity is central to accelerate economic growth and improving the wellbeing of both rural and urban people in Ethiopia. Agriculture, particularly crop production, has a greater effect on both the rural and the urban poor who spend more than a half of their incomes on food. Therefore, generation and transfer of improved technologies are critical prerequisites for agricultural development particularly for an agrarian based economy such as of Ethiopian. Seed, especially that of improved varieties, are among the most important productive inputs which can take the lion`s share from other agricultural inputs in affecting productivity, livelihood and assuring food security in Ethiopia. The direct contribution of quality seed alone to the total production is estimated at 15 –20% depending upon the crop and it can be further raised up to 45% with efficient management of the other inputs. Despite the importance of improved seed in increasing crop productivity, their availability on the required amount, quality and time is still limited in Ethiopia. The unavailability of quality seed at the right place and time coupled with the poor promotion system is one key factor accounting for the limited use of improved seed, which further contributing to low crop productivity. Therefore, in order to access quality seed at the required time and amount to the farmers and increase the adoption of improved seed, there is a need to have a robust seed system which can strictly control seed outlets and a strong seed-related extension program. The present paper reviews about enhancing access and adoption of improved seeds for better food security in Ethiopia.
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1. Introduction

Agriculture is the mainstay of the Ethiopian economy, which contributes 43% of the GDP, about 90% of the exports earning, contributes to 85% of employment, and provides direct support to the livelihood of 83% of the population (CSA, 2016). Ethiopian agriculture is characterized by mixed crop-livestock farming systems (Elias and van Beek, 2015). A close look at the performance of the Ethiopian agriculture reveals that, it has been unable to produce sufficient quantity to feed the country's rapidly growing human population (Diao *et al.*, 2007). Low crop productivity in Sub Saharan Africa (SSA) including Ethiopia is due to a limited availability and use of improved seed by farmers. The supply of certified seeds of grain crops in Ethiopia is estimated to be about 10% of the annual seed planted (Spielman *et al.*, 2010).

Seed is the basic agricultural input, and access to preferred and adapted seed is a prerequisite for sustainable crop production (Sperling and McGuire, 2010). Increasing quality and usage of improved seed (along with other best practices such as irrigation, fertilizer adoption and mechanizations) has the potential to dramatically increase Ethiopia's annual crop productivity (Alemu, 2010). The direct contribution of improved seed alone to the total production is estimated at 45%, which depends upon the type of the crop. While using other improved technologies, the contribution of seed to productivity is much increased (Abebe and Alemu, 2017).

Food insecurity is a manifestation of poverty confronting in many developing countries, especially those found in Sub-Saharan Africa including Ethiopia. For instance, about one third of the people in SSA are food insecure (Graaff *et al.,* 2011). Ethiopia is the fourth African country scoring (37.1%) of the population being undernourished/ in hunger (ADB, 2014; Abdulahi, 2017). Agricultural growth especially crop production is a best-bet strategy for achieving food security. This can be achieved through an enhanced seed availability that will improve smallholder farmers' access to improved seed and enhance improved variety adoption (Adekambi *et al.,* 2009). Improved seed is pivotal in the improvement of food security and farm household livelihood (Sanchez *et al.,* 2009; McGuire and Sperling, 2011). Therefore, farmers' access to quality seed, as well as the introduction and adoption of improved varieties is of crucial to smallholder farmers in Sub-Saharan Africa including Ethiopia's.

2. Enhancing Access and Adoption of Improved Seed for Food Security

2.1. The role of agriculture in Ethiopian economy

Agriculture is the mainstay of the Ethiopian economy, which contributes 43% of the GDP, about 90% of the exports earning, contributes to 85% of employment, and provides direct support to the livelihood of 83% of the population (CSA, 2016). To feed the growing population of the country, the Ethiopian government and

development partners/organizations are working to increase agricultural productivity, which will make a direct contribution to the country's economic development (Bishaw and Alemu, 2017). Ethiopian agriculture is characterized by mixed crop-livestock farming systems. *Teff*, maize, wheat, barley and sorghum, in that order, are the major cereal crops in Ethiopia (Elias and van Beek, 2015).

A close look at the performance of the Ethiopian agriculture reveals that over the last three decades it has been unable to produce sufficient quantity to feed the country's rapidly growing human population (Diao *et al.*, 2007). It is not worthy that food aid has been accounting for a significant proportion of the total food supply in the country. For instance, Ethiopia received 726,640 metric tons of food aid yearly over the 1985-2000 periods. This is equal to about 10% of the national food grain production (Abebe and Alemu, 2017). Low crop productivity in Sub Saharan Africa (SSA) including Ethiopia is due to a limited use of improved seed by farmers. The supply of certified seeds of grain crops in Ethiopia is estimated to be about 10% of the annual seed planted (Spielman *et al.*, 2010).

As discussed by Alemu *et al.* (2007) the most serious problem in meeting the accelerated growth target is the lack of growth in the production of high-quality seed. There has been little growth in use of certified seed. Fertilizer use cannot be expected to grow rapidly without large scale use of improved seed. That is only possible if improved varieties and practices are constantly provided as fertilizer use rises. That in turn depends on huge quantities of certified seed. Production of breeder seed by the research system needs to accelerate markedly. This is now a major bottleneck in Ethiopian agriculture (Alemu and Spielman, 2006).

Therefore, the current main goal of the Government of Ethiopia's Agricultural Development Led Industrialization (ADLI) strategy is to raise crop yields through a centralized and aggressive extension-based push focusing on technological packages that combined credit, fertilizers, improved seeds and better management practices. Policy makers assumed that significant productivity growth could be easily achieved by improving farmers' access to technologies which would narrow the gap between farmers' yield and exploitable yield potential (Abebe and Alemu, 2017).

Table 1. The contribution of agriculture in real GDP of Ethiopia and its growth rates.

Sub sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Crop	83.4	95.8	106.4	114.9	122.3	133.0	146.8	154.1	166.7	177.7
Livestock	30.9	32.4	34.9	37.5	40.1	42.6	45.8	48.3	50.8	51.8
Forestry &fishing	16.5	16.9	17.4	18.2	18.8	19.4	19.9	20.6	21.3	22.3
Manufacturing	10.1	11.2	12.1	13.3	14.5	16.1	19.0	21.2	24.8	27.6
Construction	10.0	11.1	12.3	13.7	15.3	16.9	19.1	25.1	34.8	47.5
Other industry	5.7	6.2	6.3	6.9	7.5	8.9	11.7	13.2	14.3	14.5
Trade, hotel and others	73.6	83.1	95.8	110.2	124.4	139.0	159.5	175.6	196.2	222.6
Finance & real estate	21.2	24.8	28.6	34.3	39.8	45.7	56.0	60.5	61.1	65.3
Gross domestic product	251.4	281.5	313.9	349.0	382.7	421.8	477.7	518.6	569.9	629.3
Real per capita GDP	3,636	3,957	4,277	4,597	4,934	5,317	5,895	6,252	6,697	7,202

Source: National Bank of Ethiopia (2014).

2.2. The role of seed in agricultural production

Seed is the basic agricultural input, and access to preferred and adapted seed is a prerequisite for sustainable crop production (Sperling and McGuire, 2010b). It significantly contributes for higher crop production along with other inputs. The direct contribution of quality seed alone to the total production is estimated at 45%, which depends upon the type of the crop. While using other improved technologies, the contribution of seed to productivity is much increased (Abebe and Alemu, 2017). Seed is crucial to food security, hence household nutrition. For example, for rural household to have an adequate diet, they should be able to have a variety of seeds which allow them to produce different types of crops. The availability of seed supported by other input and service are importance for increased crop yield and agricultural production and in most cases, guarantee household food security. Good supply systems ensure farmers' or households sustained ability to access sufficient quality of the desired types of seed at right time (Kiwanuka and Kintu, 2004).

Increasing quality and usage of improved seed (along with other best practices such as irrigation, fertilizer adoption and mechanizations) has the potential to dramatically increase Ethiopia's annual crop productivity (Alemu, 2010). According to Dercon and Hill (2009) for example, by adopting commercial seeds in combination with best practices on a quarter of the current crop area, farmers could increase maize productivity by over 60 % and self-pollinated crop production (such as wheat) by over 30 %. Data shows that the total amount of improved seed used, and the area of farmland covered by improved seed have increased during recent years. For example, the total area covered by improved seed, during main cropping season, increased from 44,918.6 ha in 2006 to 122,508.4 ha in 2015 (Sissay *et al.*, 2017).

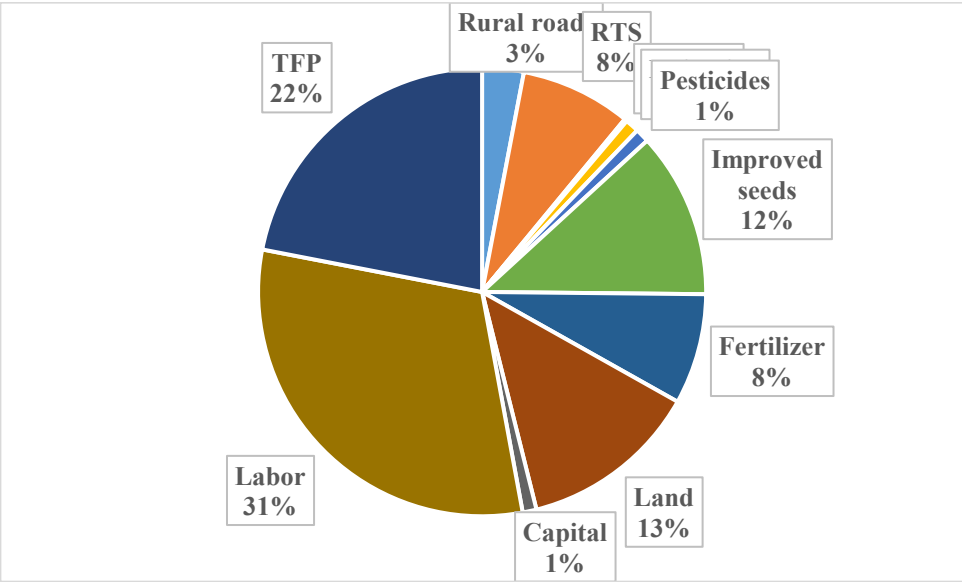

Figure 1.Contribution percentage of improved seeds with other inputs in crop production.
Source: National Bank of Ethiopia (2014).

2.3. The Concept of Seed Security

Seed security can be defined as a situation where farmers are certain, year after year, to obtain on time the quality and quantity of seed necessary to fulfill their production plans (McGuire and Sperling, 2011). The seed security basically has two important attributes: the availability of and access to quality seed. Emphasis is also placed on the timing, and quality access to availability seed for all farmers in the community (Abebe and Alemu, 2017). Seed security include the aspects of utilization in addition to availability and accessibility. Further, seed security clearly distinguishes between seed availability and seed access (Remington *et al.,* 2002).

Families are 'seed secure' when they have access to seed of adequate quantity, of acceptable quality, and in time of planting (Sperling, 2008). The aim of household seed security is to improve and strengthen the household food production capacity thus enabling farmers to retain seed of their preferred local varieties (Almekinder and Louwaars, 1999). For poor farmers with no planting material, seed security refers to access to seed to maintain food production while both in normal and disaster years, is a prerequisite for increasing food production, improving farmers' income, alleviating poverty and eventually ensuring food security (Bishaw *et al.,* 2008). To support farmers to be secured in seed accessibility and availability, various strategies have been developed and practiced in different countries including the development of seed security framework (Sperling, 2008)

2.3.1. Seed availability

Seed availability refers to the sufficient quantity seed supply within reasonable proximity to people (spatial availability) and offer in time for critical sowing periods (temporal availability) (McGuire and Sperling, 2011). Under this definition, adequate availability of seed exists when there is sufficient seed from own saved seed, through social networks, in local markets, from the formal seed sector and seed aid suppliers to meet seed needs of local households. The available seed should be in reasonable proximity to the farmer and be available in time for planting (Remington *et al,* 2002, Sperling *et al*., 2008).

There are different indicators of seed availability at the household levels including quantity of own saved seed stored at the household; quantity of seed known to exist within social networks; quantity of grain of preferred varieties and crops available in the local markets at planting time which farmers could use as seed; quantity of seed available with seed companies and local seed source at planting time; prices of seed in local markets and seed companies; proximity of seed sources in relation to the household (McGuire and Sperling, 2011). However, there are several internal (household financial, networks *etc*.) and external (conflict, drought *etc.*) factors that are responsible for poor seed availability at household levels. Walsh *et al.* (2004) for instance, explained that if there is a complex emergency of civil conflict over a wide area and drought that has disrupted usual farm-saved seed supply and operation of local markets, seed could not be available within a reasonable distance to vulnerable populations.

2.3.2. Seed accessibility

Access to seed can be defined as the ability to acquire seed through exchange, loan, barter (*i.e*. in exchange for another commodity or service such as labor) or use of power in social networks (McGuire and Sperling, 2008). Thus, whilst seed may be available within a social network, it may not be accessed due to lack of power, status or influence of the household to acquire it. Seed may be obtained through barter, and it may be given on loan on the

condition that an equal or greater quantity would be returned later. Seed may also be acquired through the market place in exchange for cash, in local markets using barter mechanism or in registered seed distributors (formal sector) (Sperling, 2008). There are several indicators for seed accessibility including amount of seed accessible by the household through social networks (social access); level of household income obtained through different sources; wealth of household and purchasing power of households (Walsh *et al.,* 2004).

2.3.3. Varietal suitability

Varietal suitability refers to the ability of farmers to access seed of crop varieties which have the characteristics that they prefer (Remington *et al.,* 2002). There are a range of desirable characteristics which may differ among farmers. The most commonly cited desirable characteristics include: appearance, storability, high income potential, high production potential, and disease and pest resistance/tolerance in the field (McGuire and Sperling, 2011). Households require seed of crop varieties that they know, prefer and are confident to plant. In some cases, farmers can specifically identify the seed of the varieties they use. This is also why farmers need to trust the seed seller since varieties cannot always be identified by looking at the seed (Remington *et al*., 2002). Available literature suggested some of the key indicators that are commonly used for varietal preference/suitability. These indicators include the level of farmer satisfaction with the crop and varieties they are currently growing or desire to grow; specifically, desired characteristics which are/ are not present in the varieties which they are currently growing; number and types of problems related to current varieties (duration, pest, yield); and farmer access to accurate and useful information about varieties they are being provided (Sperling, 2008).

2.4. The concepts of food security

Food security is a concept that has evolved considerably over time and its definitions developed and diversified by different researchers, scholars and organizations (Abdulahi, 2017). Food security and insecurity are the terms used to describe whether households have access or not access to sufficient quality and quantity of food. With progress in time and severity of the problem, food security issues gained prominence and great attention at the global, national, household and individual levels. Such progressive work by scientists led to redefining the scope and depth of food security concept. For instance, (Duffour, 2010), explained the concept stating that food security at global level does not guarantee food security at the household or individual level.

According to FAO (2008) food security is a situation that achieved at the individual, household, national, regional and global levels when all people, always, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. On the other hand, in the recent studies, food security is defined as adequate availability of and access to food for households to meet the minimum energy requirements as recommended for an active and healthy life (Hussein and Janekarnkij, 2013).

Food insecurity is a situation which occurs at individuals, households or nation level that has neither physical nor economical access to the nourishment they need. Household is said to be food insecure when its consumption falls to less than 80 percent of the daily minimum recommended allowance of caloric intake for an individual to be active and healthy (Devereux, 2000). Particularly, food insecurity includes low food intake, variable access to food, and vulnerability- livelihood strategy that generates adequate food in good times but is not resilient against shocks. These outcomes correspond broadly to chronic, cyclical or seasonal and transitory food insecurity, and all are endemic in Ethiopia (Hussein and Janekarnkij, 2013).

Chronic food insecurity: It is long-term and continuously inadequate diet caused by the inability to acquire food. It affects households that persistently lack the ability either to buy enough food or to produce food by their own food production system (FAO, 2005; Hart, 2009).

Seasonal or cyclical food insecurity: May be evident when there is a recurring pattern of inadequate access to food such as prior to the harvest period (the "hungry season") when household and national food supplies are scarce or the prices higher than during the initial post-harvest period (Devereux, 2008; Hart, 2009). It is generally considered to be more easily predicted than temporary food insecurity as it is a known and regular occurrence.

Transitory food insecurity: It is usually sudden in onset, short-term or temporary and refers to short periods of extreme scarcity of food availability and access (Barrett and Sahn 2001; Hart, 2009). Such situations can be brought about by climatic shocks, natural disasters, economic crises or conflict. Experiences of transitory food insecurity may arise through smaller shocks at the household level, for example, loss of income and crop failure while not the normal state of affairs shocks can be severe and unpredictable (Hart, 2009).

2.4.1. Dimension of food security

According to1996 World Food Summit, food security exists "when all people, always, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Based on this definition FAO (2008) developed four main dimensions of food security which are food availability, food accessibility, food utilization and stability. Examining the dimensions of food security provides a more comprehensive picture, and can also help in targeting and prioritizing food security and nutrition policies and programmes.

Food availability

Food availability refers to the presence of food at global, national, household and individual level, example when "sufficient quantities of appropriate, necessary types of food from domestic production, commercial imports, commercial aid programs, or food stocks are consistently available to individuals or nations" (Anderson, 2015). The food availability indicators capture not only the quantity but also the quality and diversity of food. For assessing food availability, adequacy of dietary energy supply, share of calories derived from cereals, roots and tubers, average protein supply, and average value of food production should be analyzed (Abdulahi, 2017).

Food access

It refers to the resources that households must obtain foods, either through own production or through purchase. Food access is largely related to household income and own production (Anderson, 2015). According to (Kuwornu *et al.,* 2013) food access depend on; income available to the household, the distribution of income within the household, the price of food in the market and other factors worth mentioning are individual's access to the market, social and institutional rights.

Food utilization

Food utilization refers to the nutritional benefits derived from food consumption which is related to proper food processing, storage techniques, adequate knowledge of nutrition; and adequate health and sanitation services exist. Hence food utilization is largely related to nutrition, health and sanitation (Anderson, 2015). The same to this (Jrad *et al.,* 2010) have define food utilization as proper biological use of food, requiring a diet that contains sufficient energy and essential nutrients as well as knowledge of food storage, processing, basic nutrition, child care, and illness management.

Food stability

Food stability refers to the stability of all other dimensions of food security over time. As discussed by FAO (2008) if a food intake is adequate today and inadequate access to food on a periodic basis, still it is food insecure. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status. Therefore, food security to be insured at global, regional, national, household and individual level food stability should be maintained (Abdulahi, 2017).

2.4.2. Status of food security in Ethiopia

As indicated by Africa Food Security and Hunger/ Undernourishment Multiple Indicator Scorecard (AFSHMIS), Ethiopia ranked as first in having the highest number of people in state of undernourishment/ hunger which is 32.1 million people. This makes it, the fourth African country scoring (37.1%) of the population being undernourished/ in hunger (ADB, 2014; Abdulahi, 2017). The livelihoods of rural Ethiopian people are highly sensitive to climate. Food insecurity patterns are seasonal and linked to rainfall patterns, with hunger trends declining significantly after the rainy seasons (Anderson, 2015).

According to Abdulahi (2017), Ethiopia has been a net importer of food for more than three decades. In the decade between 1985 and 1994, net domestic production of cereals that on average account for about 85 per cent of household food consumption ranged between 82.7 and 93.8 per cent of total supply. Different factors are contributing to vulnerability of the country which includes rapid population growth with low crop productivity due to unavailability of fertilizer, improved seed and other agricultural inputs. According to UNICEF (2014), about 10 percent of Ethiopia's citizens are chronically food insecure. In Ethiopia 2.7 million People require emergency food assistance and 238,761 children require treatment for severe acute malnutrition. The estimated number of food insecure people was 4.5 million in august 2015 and by the end of the same year this figure had more than doubled to 10.2 million Ethiopians (Abdulahi, 2017).

2.5. Linking between seed and food security

Definitions of seed security and food security are remarkably similar. Both include aspects of availability, access and utilization (Remington *et al*., 2002). The aim of household seed security is to improve and strengthen the household food production capacity thus enabling farmers to retain seed of their preferred local varieties (Almekinder and Louwaars, 2008). For poor farmers with no planting material, seed security refers to access to seed to maintain food production (Bishaw *et al*., 2008). The two are linked, but far from the same (Sperling *et al*., 2008). Seed security and food security come one after the other in agricultural rehabilitation programmes. Thus, seed security, both in normal and disaster years, is a prerequisite for increasing food production, improving farmers' income, alleviating poverty and ensuring food security (Bishaw *et al*., 2008). According to Remington *et al.* (2002), there are different parameters of seed and food security: availability (from production, trade, and transfers), access (entitlements) and utilization (whether food/seed can meet users' needs).

Table 2: Linking between food and seed security.

Parameters	Food Security	Seed Security
Availability	Sufficient quantity of food within reasonable proximity to people	Sufficient quantity of seed within reasonable proximity to people (spatial availability), and on offer in time for critical sowing periods (temporal availability)
Access	People have capacity to produce, adequate resources to otherwise obtain food	People produce own seed, or have adequate resources to otherwise obtain seeds
Utilization	Households can use the food they have, which meets their needs (food processing, storage, nutrition, child care, health and sanitation practices)	Seed is of acceptable quality (seed health, physiological quality), and meets farmer needs (is adapted and aligned with farmer preferences)

Source: McGuire and Sperling (2011).

2.6. Seed supply system and food security in Ethiopia

A study by Almekinders (2000) shows that poverty is strongly related with increased use of off farm seed sources. Poor household are often not capable to save seeds for next planting since their crop production is often below the subsistence level. Study done by Sperling *et al.* (2008) revealed that, the reasons such as loss of seed due to crop failure, incapability to save seed because of low yield of the previous seasons, need to replace seed because of degenerate or disease contamination, and need to acquire new cultivars may motivate farmers to use off-farm seed. Small scale seed production (including strengthening farmers' seed production) are important for seed availability. In addition, the benefit of small-scale farmers from commercial seed activities include, increasing production through increment in productivity, increasing the income of the small farmers and improving agricultural seed and other input market and improving food security and promoting the transformation toward a sustainable commercial agricultural sector (Giusti, 2004).

A study conducted by Wale and Detlef (2007) revealed that conservation of varietal diversity on farm is mainly a poor man's undertaking with little access to cash crop farming, markets, improved varieties and extension. McGuire (2007) in his study used profit regression model to show how maintaining seed security is a central concern for household and drives many practices in the seed system, and how vulnerability to seed security varies between household and agro ecology. The result shows farmers' most important source of planting material is their own saved seed. A study by Mekibib (2008) on sorghum seed shows that farmers have the capacity to produce good quality seed and grain production which is based on their own seed or seed obtained from farmers' seed system. For seed security farmers seed system is more important than the formal seed system. Bishaw *et al.* (2008) reported that seed security for food security can only be achieved in the developing countries, if strategies and mechanisms are designed to protect the local crop diversity and improve the seed supply sector.

2.7. Potential seed producers and suppliers in Ethiopia

To date, one federal and three regional public seed enterprises and around 33 private seed companies are actively involving in seed production and supplying to growers in Ethiopia (Atilaw *et al.,* 2017). There are also different research organizations, devolvement partners, NGOs *etc.* working in supporting the seed production, distribution and marketing activities. Moreover, government institutions and decision makers are playing crucial roles in creating enabling environment for better seed production and distribution. All these actors and stakeholders, in one way or another, contribute to production, promotion, supply and marketing of improved seed in the country (Atilaw and Korbu, 2011). However, studies show that only a small area of land is covered by improved seed; for instance, between 2005/6 and 2009/10, only 3.5% of the land was planted with improved seed out of a total of 12 million hectares of land under major food crops (Sissay *et al.,* 2017).

In recent years the total amount of improved seed used, and the area of farmland covered by improved seed have increased. The total area covered by improved seed, during main cropping season, increased from 44,918.6 ha in 2006 to 122,508.4 ha in 2015 (Sissay *et al.,* 2017). However, seed production by formal seed system focused mainly on a few cereal crops particularly for hybrid maize and wheat. For example, wheat and hybrid maize constitute about 85% of the total seed production (Marja *et al.,* 2008). Unlike to the formal system, the informal system covers the lions' share of seed used by small-scale farmers. Because of the strength of seed networks, low cost and its potential to satisfy the diversified seed demand of the farming community, the informal seed system provides many opportunities for increasing seed security. Local institutions including, Seed Producer Cooperatives (SPCs) can provide diversified crops & varieties for farming community with reasonable offer. SPC are engaging in quality seed production and marketing based on the local demand for quality seed of particular crops and varieties that are not addressed by the formal system (Atilaw and Korbu, 2011).

Private seed companies (producers) have shown significant contribution in improving the supply of seed to farmers. Pioneer Hi-bred Ethiopia, a multinational private company, is the first private seed company that started its operation in the 1990s, following the economic reforms (FCA, 2016). Gradually, other private seed producers started to engage in the Ethiopian seed business. The private seed sector has made some initial forays into Ethiopia's seed industry during the past decade, and more specifically into the maize seed business (Atilaw and Korbu, 2011). Although private seed companies are limited to a few crops, their share of seed volume has increased. Private producers in aggregate provide 32% of the total formal seed supply in the country (Sissay *et al.,* 2017). The same authors reported as the volume of seed production by private producers has increased from 4,994.1 tons in 2012/13 to 9,819.2 tons in 2014/15. More specifically, the contribution of private producers is high for hybrid maize seed production and distribution. The other actors involved in seed production and distribution are seed producer cooperatives. They produce seeds of diversified crops and varieties (FCA, 2016). Large numbers of multipurpose cooperatives are also involved in seed production. Currently, several seed unions have established in different part of Ethiopia. These unions are legally registered enterprises to produce and sell seed (Sissay *et al.,* 2017).

Table 3: Amount of pre-basic and basic seed produced (tons) by ESE (2006 – 2015)

Cropping season	**Pre-basic seed (t)**				**Basic seed (t)**			
	Cereals	Pulse crops	Oil crops	**Total**	Cereals	Pulses	Oilseeds	**Total**
2006	119	24	4	147	1,279	165	16	1,460
2007	168	27	4	199	1,798	140	13	1,951
2008	228	44	4	275	2,210	209	26	2,444
2009	288	54	7	349	3,669	172	35	3,876
2010	536	84	9	629	3,594	235	144	3,973
2011	613	36	6	655	7,469	308	85	7,862
2012	419	49	7	475	2,948	231	60	3,239
2013	180	34	6	219	3,307	248	132	3,688
2014	308	31	2	341	2,828	228	75	3,131
2015	2,858	383	49	3,290	4,997	149	93	5,239

Source: Atilaw *et al.* (2017).

2.7.1. Status of improved seed adoption in Ethiopia

Adoption of improved varieties of widely grown crops such as teff, maize, sorghum and common beans is low (Spielman *et al.*, 2010). Despite the release of several technologies, particularly of improved crop varieties, there has been limited use of improved seeds by most farmers (Mugonozza, 2001; Doss *et al.,* 2003). Official estimates from the Central Statistics Agency (CSA) show that while the total quantity of improved seed supplied nationally has been increasing, farmer use of improved seed is low.

A study by Atilaw and Korbu (2011) revealed that, between 2005/6 and 2009/10, only 3.5% of the land was planted with improved seed out of a total of 12 million hectares of land under major food crops. However, the total amount of improved seed used, and the area of farmland covered by improved seed have increased during recent years. The following figure is reported by Sissay *et al.* (2017) which illustrates the trend of the total area of coverage by improved seeds for the decade (2005/06 to 2014/15) by smallholder farmers. It also displays the amount of improved seed used to cover the area of land. The total area covered by improved seed, during main cropping season, increased from 44,918.6 ha in 2006 to 122,508.4 ha in 2015. Similarly, the total amount of seed used increased from 26,585.7 tons in 2006 to 51,425 tons in 2015.

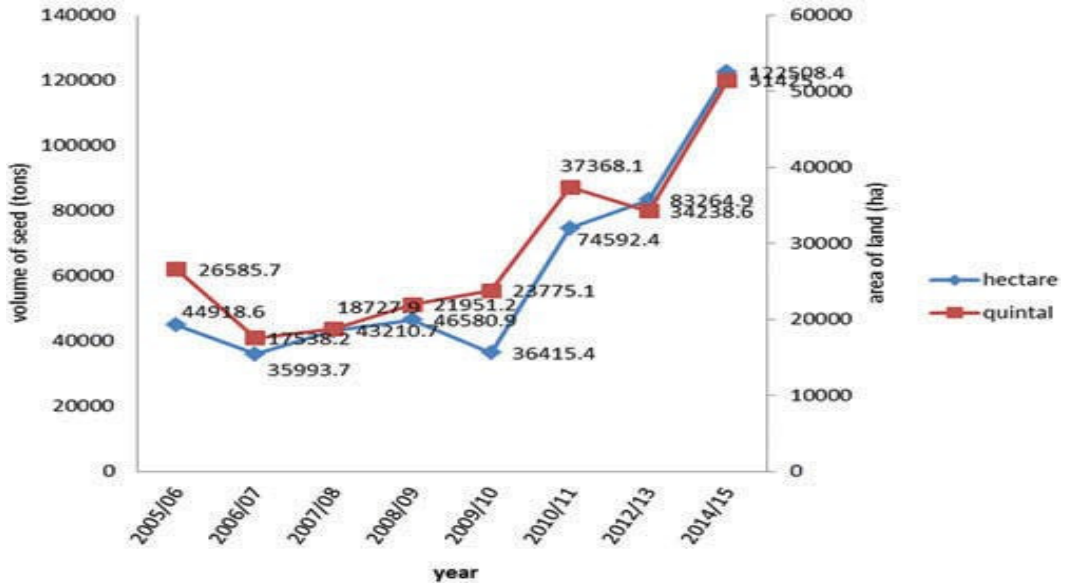

Figure 2. Areas covered by improved seed and amount of seed used across years by smallholder farmers. Source: (Sissay *et al.,* 2017)

2.7.2. Challenges in adoption of improved seed

Adoption of improved varieties of widely grown crops such as teff, maize, sorghum, common beans and etc. is low (Spielman *et al.*, 2010). Despite the importance of quality seed in increasing crop productivity, their availability on the required amount, quality and time is still limited in Ethiopia (Thijssen *et al.* 2008). The unavailability of quality seed at the right place and time coupled with the poor promotion system is one key factor accounting for the limited use of improved seed, which further contributing to low agricultural productivity (Atilaw and Korbu 2010). To improve the situation and help farmers to access quality seed at the required time and amount, there is a need to strengthen the seed systems (Alemu, 2011; Sissay *et al*., 2017). Farmers are accessing seed from different sources with different quality standards (Louwaars and de Boef 2012). They can access the seed from different seed systems i.e. formal, informal and intermediate seed systems (Hassena and Dessalegn, 2011; Hirpa *et al*., 2010; Sisay *et al*., 2017).

The limited extension supports and popularization of the newly released varieties is another challenge in adoption of improved seed in Ethiopia. Variety popularization and seed promotion by various organizations is limited compared to the vast number of farming communities in Ethiopia. Many improved varieties produced by formal sector are not known to farmers, even to extension personnel (Bishaw *et al.,* 2008). For smallholder farmers, the big challenges are high seed price and late delivery, exacerbated by poor rural infrastructures making it hard to reach farmers in remote and isolated villages (ESE, 2000).

2.8. Seed distribution in Ethiopia

The Ethiopian Seed Enterprise (ESE), a parastatal company, has been a key player in the production and distribution of newly released improved seed varieties. In the past the ESE used to produce most of the newly improved varieties on its own farms, as well as on state farms, with large private farms playing only a minor role in production of new varieties. However, given the consistent shortage of base seed in the system, there has been an increasing decentralization in distribution, with other seed distributors being allowed to participate in the system to cover seed shortages (Alemu *et al.,* 2010).

Regional research institutes and private seed companies have therefore become more important over time in improved seed distribution, and it is estimated that there are now more than 30 private, agricultural cooperatives, and parastatal seed producers in Ethiopia (Benson *et al.,* 2014). While there are still important problems relating to timeliness of seed delivery and the quantity and quality of seed provided (Spielman *et al.,* 2012; Spielman and Mekonnen, 2013; Benson *et al.,* 2014). Better seed availability has improved over the last decade, which has led to higher adoption rates and contributed to higher agricultural growth (Benson *et al.,* 2014).

To supply improved seed on time in the required quality and quantity there is a need to understand what a seed system is, and we need to consider its three components-technological, economic and legal. The technological component has to do with variety selection; the economic one involves production and marketing; and the legal component has to do with the rules and regulations governing the previous two aspects (Singh *et al.,* 2006). Investments in plant breeding and varietal development would also be a waste if the improved seed are not passed on to farmers in the form of quality seeds. It is important that improved and high-quality seeds are disseminated to farmers at the right time and in the right quantity and quality; because farming activities depend on a continuous

supply of good quality seeds and planting materials (Abebe and Alemu, 2017).

Greater percentage of improvement in agricultural production has come from the use of improved seed. No agricultural practices, i.e. fertilization, irrigation etc. can improve crop production beyond the limit set by seed. In ensuring this, seeds of new varieties must be made available to the farmers in adequate quantity and quality and at affordable prices and on time. The development and performance of the seed sector is constrained by many factors which include weak technical capacity, poor market mechanisms and inefficient enforcement of seed law, information asymmetry, insufficient capital investment and low utilization of innovations (Abebe and Alemu, 2017).

2.9. The overall effect of adopting improved seed on livelihood and food security

Different authors (e.g. Dixon *et al.,* 2006; Wanyama *et al.,* 2010), suggests that adoption of improved varieties can have impacts at different levels. First, improved seed can generate significant field-level impact on yield and stability. Second, higher and more stable improved seed yields produce people-level impacts on household food security and household income. Third, it creates further household level impacts on wider dimensions of household livelihoods and poverty reduction. Several studies in Africa show that adoptions of improved agricultural technologies had positive impacts on income, food security and poverty reduction. Access to improved seed has had significant impacts in the lives of Ethiopian farmers. This can be seen through several indicators such as improved productivity, increased income, improved food availability and enhanced access to livelihood assets like livestock, home utensils and house. Importantly, the beneficiaries have been able to feed their family and reduced months of food shortage (Adekambi, *et al.,* 2009*;* Solomon Asfaw *et al.,* 2010).

Adoption of improved agricultural technologies (improved varieties and agronomic practices) have positively and significantly affected household's food security in Ethiopia (Ferede *et al.*, 2003). Asfaw *et al.* (2010) have investigate on the impacts of adoption of chickpea varieties on the level of commercialization of smallholder farmers in Ethiopia. They found that adoption of improved chickpea varieties has a positive effect on marketed surplus which reduces food insecurity in adopter households. A study by Adekambi *et al.* (2009) on the impact of agricultural technology adoption on poverty indicates the increase in productivity of rice farmers, following the adoption of improved varieties. These results suggest that the promotion of using improved seed can contribute to improving expenditure/income of farmers and consequently to poverty reduction.

Another study by Eneyew (2017) on the role of adopting improved seed revealed that the yield of the maize cultivars ranged from 39.13 to 59.65 q/ha for non-beneficiaries and beneficiaries of improved seed respectively. This indicate that beneficiaries produced 20.5 q/ha of maize higher than non-beneficiaries. The same author also reported that, adopting improved seeds has increased the diversity of meal consumed, quantity of food consumed, family income and relative quality of meal of beneficiaries. The proportion of beneficiaries with improved dietary diversity, intake and income are significantly higher than that of non-beneficiaries. Similarly, the average frequency of meal consumed by beneficiaries and non-beneficiaries was 1.78 and 1.63 respectively and this is statistically significant figure. A reduced level of dietary diversity and intake for majority of non-beneficiaries is most likely a key indicator of the fact that seed has improved food security.

Adopting improved seed also enhance capability to buy food and nonfood items. As discussed by Melese *et al.* (2009) beneficiaries and non-beneficiaries of improved seed spent 53.5% and 65.6% respectively for consumption. Increasing food expenditure share means households have less resource to spend on other non-food consumption goods like on education, health, and consumer durables.

Table 4: Food security indicators of beneficiaries and nonbeneficiaries of improved seed.

	Increased	Same	Reduced
Diversity of meal			
Beneficiary	61.3%	15.6%	23.1%
Non-beneficiary	11.1%	20.8%	67.4%
Quantity of meal			
Beneficiary	69.4%	11.0%	19.1%
Non-beneficiary	16.6%	32.4%	51.0%
Family income			
Beneficiary	67.6%	12.1%	19.7%
Non-beneficiary	9.0%	28.3%	62.8%
Quality of meal			
Beneficiary	57.2%	23.7%	19.1%
Non-beneficiary	7.0%	29.4 %	63.6%

Source: Eneyew (2017).

3. Conclusion

Adopting modern agricultural inputs including improved varieties is the pillar for increasing crop productivity and overcoming the problems of food insecurity in Ethiopia. Since rural households are basically entitled to food through own production, higher agricultural productivity can easily translate to a better food security condition among these households which could be manifested by higher consumptions. To feed our exponentially growing population, there is a need to increase the production and productivity of agricultural output including crop productivity; to achieve this the use of modern agricultural technologies are vital, out of which high yielding variety of crops and fertilizer coupled with recommended agronomic practices are the most important technologies which takes the lion's share. From this review it is observed that, when there are different seed sources available and farmers get access to them there will be high probability of adoption of improved varieties. An enhanced seed availability through formal, informal or intermediary sources will improve smallholder farmer's access to seed and enhance improved variety adoption which improve livelihood and food security in Ethiopia. However, according to this review the challenge in Ethiopia today is to develop seed production and delivery systems that encourage wider use of improved seeds. While the formal, informal and intermediary seed systems exist in Ethiopia, evidence shows that majority of farmers are rely on the informal seed system for seed and planting material for most agricultural commodities, and often continue to recycle seed.

4. Future line of work

Even though adopting improved seed is important in improving livelihood and food security in Ethiopia, research on the contribution of improved seed in assuring food security is in its infancy level. This situation enables role of improved seed research to be placed on the right track from the onset. To feed our exponentially growing population, there is a need to do further research on the link between seed and food security. Unavailability of quality seeds at the right place and time coupled with poor promotion system, is one of the key factors accounting for limited use of improved seeds. Therefore, to enhance improved seed supply a well-functioning seed system is deemed crucial. In Ethiopia considerable resources have been devoted to the development and release of improved varieties though their adoption has been remained low. Therefore, there is a need to invest in a strong seed-related extension programs to encourage the distribution and adoption of improved seeds.

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