Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.3, 2015

Challenges and Opportunities of Seed Multiplication in Eastern Tigray Ethiopia

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Abstract
Seed is the most important agricultural input and it is the basic unit for distribution and maintenance of plant population. Improved crop varieties play a critical role in agricultural intensification. In Ethiopia, as in many other countries in sub-Saharan Africa, the informal seed system is still the dominant system for seed supply. Though there are three systems in Ethiopia farmers in our zone most dominantly uses their own seed your after your. This is because shortage of improved varieties in the area in addition to the awareness they have. To increase production and productivity in the zone farmers should get improved varieties in time and in amount of different crops. For the achievement of this, collaborative efforts of all stake holders in capacity building on crop production and post harvest handling, development of high yielding widely adapted cultivars with better resistance to diseases and pests, development of improved agronomic and managemental practices is very essential. The potential of the zone can produce its own seed and cover the demand of farmers not only in the surrounding but also the Region as a whole. However the assumption of scholars and the actual ground is not compatible. So, The Aim of this paper is to review the production, role of farmers training center (FTC) in seed production, potentials, challenges and future opportunities in seed multiplication.
Keywords: Challenge, FTC, Potential, Production, Seed

1. Introduction

Seed is the genetic material, which is the first link in the food chain, source of life, future plant and even source of culture (Shiva et al., 1995). The importance of seed as the carrier of most important characteristics for crop production has been recognized since the early days of agriculture. Starting from 10000 years ago, harvesting seed from preferred plants has been the basis of crop domestication and consequently of present day agriculture (Louwaars and Gam, 1999).

Seed is the most important agricultural input; it is the basic unit for distribution and maintenance of plant population. It carries the genetic potential of the crop plant. It thus dictate the ultimate productivity of other input such as fertilizer, pesticide irrigation water etc., which build the environments that enable the plant to perform (Mugonozza, 2001). Seed is generally considered to be the most affordable external input for farmers, and many of its benefits are assumed to be 'scale-neutral'. So investments in crop improvement potentially can reach a wide range of farmers. While many other areas are also important for agricultural development – such as markets, credit supply, support institutions, and policies –access to appropriate seed is clearly the first step (McGuire, 2005).

A study by Boussard *et al*. (2005) found that 99% of the food in Sub-Saharan Africa is grown under rain fed agriculture. Hence, food production is vulnerable to adverse weather conditions. The reason behind is that there was an over decline in farm input investment including fertilizers, seeds, and technology adoptions.

In Ethiopia, as in many other countries in sub-Saharan Africa, the informal seed system is still the dominant system for seed supply. It is the system in which farmers select their crops and varieties, produce their own seed, and/or locally exchange and purchase seed. Annual potential seed requirement of Ethiopia is estimated to be 150,000 tons, but the formal sector supply does not exceed 20,000, or only about 13%. The formal sector plays a role in more accessible areas and mainly for a few cereal crops (Marjia, 2008). Despite the huge demand, there is a great shortage of seed supply from this formal sector. Farmer-based seed production is the cornerstone to fill the gap between the demand and supply of seed for most of the crops (ibid.).

The need to increase agricultural productivity to enhance food security and reduce poverty in Africa is widely acknowledged (World Bank, 2007). Improved crop varieties play a critical role in agricultural intensification (Evenson and Gollin, 2003) particularly when combined with external inputs and a conducive policy environment as exemplified by the Asian Green Revolution. Seed systems are complex and dynamic not least due to inherent variations in products, supply and demand side factors and their interrelated associations with the policy environment (Olfa, 2011).

The use of good quality seed of adopted and improved varieties is widely recognized as fundamental to ensure increased crop production and productivity. This is even more important in sub-Saharan Africa (SSA) in the view of increasingly available land, declining soil fertility and ever growing population; those facts increase the importance of promotion and use of good quality seed as a means to intensify food production. The potential benefits from the distribution of good quality seed of improved varieties are enormous, and the availability of

quality seed of wide range of varieties and crops to the farmers is the key to achieve food security in SSA. Enhanced productivity, higher harvest index, reduced risks from pest and disease pressure, and higher incomes are some of the direct benefits potentially accrued to the farmers (FAO, 1999).

The maximum crop yield is defined as the harvested yield of a high-producing variety, well-adapted to the given environment where water, nutrients, pests and disease do not limit the yield. The level of the maximum yield is primarily determined by its genetic characteristics and the adaptation to the prevailing environment. Environmental requirements of climate, soil and water for optimum growth and yield vary with crop and variety. Selection of a crop and variety most suited to the given environment is very crucial for obtaining high production (Doorenbos, *et al.,* 1996).

Discussions of agriculture and rural development in Ethiopia inevitably lead to the subject of seed. Through a combination of modern science and modest changes in farmer cultivation practices, improved seed can yield remarkable abundance for small-scale farmers in Ethiopia. This abundance can contribute to greater production and productivity in the agricultural sector while also addressing the country's food security and poverty reduction challenges (Dawit and Spielman, 2006; Dawit et al., 2004; Deressa et al., 2001).

Despite of seed availability in the country through improved seed production, production from the Farmer Based Seed Production and Marketing Schemes (FBSPMS) and seed imports, some regions have reported seed shortfalls (SNNPR and Tigray). Organizations engaged in the provision of seeds are also encountering difficulties locating local improved varieties for purchase and redistribution (UN, 2003). So this paper is objected to review the opportunities and challenges of seed production in eastern Tigray Zone Ethiopia.

2. Food security

In order to boost agricultural production and productivity, a concerted effort is required to generate, introduce, integrate and disseminate appropriate agricultural technology packages, which, in turn, will improve food security. Moreover, to accelerate food production and enhance the food security conditions of rural households, the functioning of input and output agricultural markets, including technological inputs and their expected net returns, need to be improved (Goshu et al., 2012).

Increasing agricultural production is one of the measures taken to assure food security and livelihood enhancement in rural areas, but this improvement can only be effective and sustainable if subsistence farmers have access to affordable quality planting materials (Mesfin, 2005). Most small-scale farmers continue to largely rely on their own materials, saved from previous seasons or obtained from neighboring farmers (Rohrbach et al., 2002). Improving the genetic and physical quality of planting materials can trigger yield increase up to 40% and lead to substantial improvement in the agricultural production and food security, especially if farmers continue to renew their planting materials stock (Maredia et al, 1999).

The eradication of poverty in Ethiopia, where smallholder farming is the dominant livelihood activity and the source of vulnerability to poverty and food insecurity, is an overriding objective of the incumbent government (FDRE, 2012; MoFED 2006; Brown & Teshome 2007). Achieving agricultural growth and development and thereby improving rural household welfare requires increased efforts to provide yield-enhancing resources. Agricultural technology can contribute to increased food production (food availability) and increased agricultural and rural incomes (better access to food), and entails positive spillovers to other sectors and contributes to economy-wide growth. Agricultural productivity growth is also vital for stimulating growth in other sectors of the economy (Moreno & Sunding 2003; Kidane *et al*. 2006).

Empirical evidence of food security in Ethiopia indicates the prevalence of a high level of food insecurity, with significant idiosyncratic and spatial characteristics. The specific food security studies by Berhanu (2004), Freihiwot (2007), Hadleya *et al*. (2011), Abebaw *et al*. (2011) and Hailu (2012) generally suggest that the depth and intensity of food insecurity are high, influenced by poor functioning of marketing systems and other household and socioeconomic factors. However, all the studies have focused little on the role and measurement of adoption of agricultural technologies, and their interdependence with the food security situation of households (Goshu *et al., 2012*).

Increasing quality and usage of improved seed (along with other best practices such as irrigation, fertilizer adoption, and mechanization) has the potential to dramatically increase Ethiopia's annual crop production. For example, by adopting commercial seeds in combination with best practices on a quarter of the current crop area, research indicates that farmers could increase maize production by over 60 percent and self-pollinated crop production (such as wheat) by over 30 percent (IFPRI, 2010). Of all the regions in Ethiopia, Tigray has been considered especially vulnerable to food insecurity mainly due to insufficient and highly variable rainfall, which constrains agricultural production (FDRE, 1999). Low agricultural productivity due to severe land degradation and low soil fertility is a critical problem, and one that characterizes the Ethiopian highlands in general (Pender and Gebremedhin, 2004). Hence, investment in irrigation development has been considered as one of the viable strategies for achieving food security (Gebrehaweria, 2012). Now day's federal and the regional state government focusing on using of different inputs (table 1) to increase the production and

productivity of the region. As a result farmers are using many inputs in off and main season like Eastern Tigray Zone (table 2).

The Eastern zone is one of the zones known for its food insecurity. Agricultural production in the area is highly constrained by factors such as degraded environment, inadequate rainfall; lack of technology, capital, and credit. Besides, agricultural land in the area is characterized by fragile and fragmented smallholdings. In the area, agriculture production is viewed by many as marginalized. So majority of farmers are involved in nonfarm employments because they believe that agricultural income is not sufficient enough to stand households food security (Bereket and Zenebe, 2011). As mentioned above the productivity is increasing through time (table 3) that can reduce the food insecurity of the area.

3. Farmers training centers and their role in seed multiplication

Establishment of Agricultural Technical Vocational and Educational Training Centres (ATVETs) and Farmer Training Centers (FTCs) belong to the package developed by Ethiopian government and its target ministries (FDE, 2008).

The FTCs are expected to serve as hubs for farmers to receive advisory services and information, training, and demonstrations on improved and sustainable farm management practices (Gebremedhin et al., 2006; IFPRI, 2010). Currently, there are about 8,500 FTCs established at the *Kebele*2 level, with roughly 2,500 of these FTCs reported to be fully functional (MOARD, 2009). Stationed at each FTC are three Development Agents (DAs) responsible for providing advisory services on livestock, crop production, and natural resource management (IFPRI, 2010). the three DAs to each *kebele* are with an assignment to facilitate the implementation of the package approach Farmers' training centres staffed by extension personnel having three years of training from technical and agricultural training colleges have been set up in different parts of the country (Abeje berhanu, 2009). But, Belay and Degnet, (2004) indicates that development agents have weak capacities to demonstrate technological packages and offer adequate technical assistance to farmers.

Although most of the FTCs and whole concept of extension services aim at establishing the modular training in all *kebeles* and is being considered as the best solution by the government, a lot of farmers still prefer the practical training instead of the theoretical training (Lenka and Jana, 2012). The primary sources of knowledge and information sharing were Extension Agents, market dealers, neighbors, FTCs and WoARD (Wuletaw, 2014). But because of lack of facilities, instructional materials, and trained manpower, Farmer Training Centers (FTCs) remained dysfunctional to serve as knowledge promotion centers to study areas (Berhanu and Dawit, 2013). In each FTC, the following parts should exist: a classroom, a DAs' office, storage for the crop production and for the presented hand tools, a toilet, and a marketing room. The marketing room (serving for the demonstration of agricultural products) is mentioned in materials as FTCs part, but has not been built in any FTCs yet. The very important part of FTC is the demonstration plot which however has not been established in all FTCs so far. All FTCs buildings are built according to the same architectural project to be uniform, many of them have not been finished yet (Lenka and Jana, 2012).

The transfer of knowledge and information concerning seed technology including training that could develop the skill of farmers found important to increase the number of willing farmers in seed multiplication activity. On the other hand, those who lack information and knowledge besides the skill to produce required seed were reluctant to involve in seed multiplication, which clearly indicate the need of improvement in extension system and particularly letting established FTC in the rural area to give continuous and standard training to the farmers (Gezahagn, 2008). The improvement of technique is more demanded than improvement of a variety. The improvement of agricultural technique gives a large space for experimenting in comparison with improvement of a variety, which is often dependent on the possibility to find out, receive or buy improved variety of seeds (Lenka and Jana, 2012).

In eastern Tigray Zone the FTCs almost have no significant importance in seed multiplication beyond giving service of storage, training farmers in different packages as most of them are unequipped and without space for demonstration package. But there are few FTCS having a role to adapt fruit crops like apple and citrus and producing vegetables for demonstration.

4. Inputs and agriculture

Previous studies shows the critical role that underdeveloped input supply and marketing systems play on input choices and technology adoption in smallholder agriculture (Shiferaw and You 2008). However, information and local availability of inputs and farmers' ability to access those inputs are critical in facilitating the process of technology adoption. Smallholder farmers in many rural areas are semi subsistence producers and consumers who are partially integrated into imperfect rural markets. Factor markets for labor, land, traction power, and credit in rural areas of developing countries are often imperfect or even missing in some cases (Holden and Pender, 2001). In these cases, access to fertilizer and improved seeds is the key threshold that farmers with positive desired demand for the new technology have to overcome.

As for fertilizer adoption, several factors affect access to improved seed. The main explanation is the fixed knowledge cost related to adoption of the new technology. Variables affecting this cost are access to extension services and the share of crop land under improved seed in the district where the household is located. Demand for improved seed conditional on access to the technology is explained mainly by production specialization and, unlike fertilizer use, by access to extension and by the total area under crops. Among household characteristics, gender is the most important variable affecting access to seed (Bingxin et al., 2011).

Effective extension is important in the seed production. Extension plays a crucial role in training farmers in seed production and is therefore a pre-requisite to establishing a seed system, particularly informal systems, where farmers need training in various aspects of seed production. Just as it is difficult for a seed system to be effective in the absence of extension, it is equally difficult for farmers to adopt extension recommendations in the absence of a seed system that satisfies the following criteria: It covers all of the crops that most farmers grow; the varieties are appropriate and endowed with critical traits. For example, for smallholder farmers in high risk areas, yield stability is more important than yield per se (Monyo et al., 2003). Ethiopian agriculture is virtually small-scale, subsistence-oriented and crucially dependent on rainfall. A closer look at the performance of the Ethiopian agriculture reveals that over the last three decades it has been unable to produce sufficient quantities to feed the country's rapidly growing population (Belay, 2004; Ashworth, 2005; Berhanu et al., 2006; Quinones, 2007). Agricultural sectors and institutions which supports it such as extension is thus key to poverty reduction in Ethiopia.

Farmers have various motivations to participate in the extension package program. A Report of Impact Assessment of Extension Intervention in Tigray (Boanr, 2002) showed that farmers participated in the extension program because they were convinced by the advice of development agents and the demonstration effects of participating farmers. The system of seed production should be supported by effective research and extension services; availability of inputs such as fertilizer, pesticide, agricultural credit; and an efficient commodity marketing system. This increases crop productivity in an area. In tigray region using inputs increases from time to time with a high result in production of the crop produced in the region (table 1). Even though the average is very low compared to the regional average different inputs are used that can increase the production and production of crop in the area (table 2).

Table 1. Inputs Applied Area and Quantity of Inputs used in Tigray region

Crop type	All crop area	All fertilizer		Improved varieties		Pesticide	Irrigation	Extension package
		ha	Q	Ha	Q	ha	ha	ha
All	849,289	543,121	249,937	20,613	28,829	64,247	23,202	332,629
Cereals	713,492	511,043	242,246	18,139	28,547	63,023	*	309,222
Pulses	36,701	10,969	2,318	*	*	1,070	862	10,944
Oil seeds	84,268	16,002	1,573	*	*	*	*	*
Vegetables	2,809	1,645	577	*	*	*	611	505
Root crops	2,335	1,695	1,390	574	*	*	1,113	1,291

Source: CSA, 2011

Table 2, Inputs Applied Area and Quantity of Inputs used in eastern Tigray zone

Crop type	All crop area	All fertilizer		Improved varieties		Pesticide	Irrigation	Extension package
		ha	Q	Ha	Q	ha	ha	ha
All	102,142	69,189	5,153	5,584	10,178	2,497	2,049	51,029
Cereals	85,169	65,001	44,028	5,451	10,178	2,428	1,575	46,976
Pulses	9,233	3,171	*	-	-	*	*	2,933
Oil seeds	1,267	*	*	-	-	*	*	*
Vegetables	183	*	*	*	*	*	106	*
Root crops	296	234	*	*	*	*	*	203

Source: CSA, 2011

Currently, extension is mostly provided by the public sector, operating in a decentralized manner where extension is implemented at the woreda level. The public sector is the single most important player, especially in terms of inputs, at the local level for smallholders. In Ethiopia, limited extension is conducted by NGOs and the private sector, usually working through the woreda-level BOARDs (Davis et al., 2009). Cooperatives and unions provide a wide variety of services, including input supply management, grain marketing, and the supply of consumer goods to members at prices that compete with local traders (Spielman et al., 2006). Some cooperatives are also involved in seed multiplication and distribution schemes, grain milling

(Rahmato, 2002). Cooperatives are becoming an increasingly important agricultural institution in Ethiopia, with the recent strong attention paid by the government to cooperatives as a key vehicle for advancing the government's agricultural and rural development agenda. Cooperatives have both the function of rural "user organizations" and of service providers (Mogues et al., 2009). At the same time, agricultural cooperatives in Ethiopia can also be characterized as "service providers," as it is, for example, predominantly through cooperatives that farmers obtain agricultural inputs and in some cases agricultural equipment (Spielman et al., 2008).

Bernard et al., (2007) found that a greater percent of households in the Tigray region participate in cooperatives than is the case in the three other leading regions (Amhara, Oromia and SNNPR). The cooperative union is engaged in projects such as dairy farms and beehive production in order to encourage its member cooperatives and individual farmers to engage in such activities. This has demonstration effects on farmers" adoption of agricultural practices. A cooperative union leader reported that these projects are successful in having such demonstration effects (Mogues et al., 2009).

Studies indicate that, under soil moisture stress, increased fertilizer application will induce rapid plant growth which will enhance the rate of evapotranspiration and the depletion of the limited soil moisture and consequently results in reduced dry matter production (Zakia et al., 2008; Grant et al., 1991). These results explain the reasons behind the reluctance of farmers in Ethiopia and in Tigray in particular to adopt improved seed and fertilizer technologies under moisture stressed rain-fed production conditions (Gebrehaweria, 2012). Fertilizer use and expenditure on improved seed per unit area in Tigray is very low by any standards (Hagos, 2003; Pender and Gebremedhin, 2004). At national level, despite more than decades of policies placing high priority on cereal intensification backed by high rate of public expenditure on seed-fertilizer technologies, Ethiopia has not seen payoffs in terms of higher and more stable cereal yields (Byerlee et al., 2007).

The production of crops trend indicates that almost the production is increasing on yearly basis from 1,246,781.8q to 1,436,680.32q in 2009 and 2013 respectively. But its area coverage is decreasing from 94695.52 ha to 89,746.91 in the year 2009 and 2013 respectively. This is may be because of land is used for infrastructure and construction as the population in the zone as well as the region is increasing. In eastern tigray, central statistical agency data showed that the zonal productivity of crops is increasing from13.17q/ha in 2009 to 16.01 q/ha in 2013 (table 3) even though this increasing in production is fluctuating and still with a very low average production comparing to national and worldwide average.

5. Seed production

Once a new variety has been developed by the plant breeder, seed providers need to increase seed so that commercial fields can be planted by farmers that wish to take advantage of new traits. This increase is necessary for all varieties of any plant species. The increase starts with a single seed, a single plant or a handful of seed (USDA-NASS, 2009a).

The seed production process consists of a sequence of stages in which seed of a new variety is multiplied to obtain sufficient quantities of commercial seed. The earlier stages are referred to as breeder seed and the intermediate stages as foundation seed. Together, these precursors of commercial seed are known as source seed. Source seed production is beset by serious bottlenecks in many national seed systems (Ravinder et al., 2007).

5.1 Seed system

Seed systems are complex and dynamic – not least due to inherent variations in products, supply and demand side factors and their interrelated associations with the policy environment. Various analytical frameworks have been put forward to analyze seed systems (Almekinders and Louwaars, 2002). Some have emphasized the dynamic nature of seed systems and perceived development paths from basic to mature seed systems (Morris, 1998; Pray and Ramaswami, 1991; Rusike and Eicher, 1997) with corresponding stage dependent policy implications. Others have argued that reality has proved more complex and that there is no blueprint seed policy implying that there is a need to understand seed systems in order to develop the corresponding seed policy options (Louwaars, 2002).

Table 3. Most dominantly produced crops in Eastern Tigray Ethiopia

Crop type	2009			2011			2012			2013		
	ha	q	q/ha	ha	q	q/ha	ha	q	q/ha	ha	q	q/ha
All	94695.52	1246781.8	13.17	95,669.34	1,720,766.80	17.99	89,959.84	1,466,305.07	16.29	89,746.91	1,436,680.32	16.01
Barley	29021.38	423051.05	14.58	32,284.75	593,793.91	18.39	30,896.72	458,897.84	14.85	29,359.36	435,383.51	14.83
Wheat	29701.81	312354.56	10.52	27,104.92	531,583.43	19.61	28,602.21	507,883.66	17.76	28,647.70	503,977.57	17.59
Teff	8607.76	138675.87	16.11	10,882.88	140,976.12	12.95	7,527.25	97,235.31	12.92	8,669.15	108,045.33	12.46
Finger millet	2597.28	34861.85	13.42	6,837.13	107,889.33	15.78	4,108.28	50,221.01	12.22	4,178.62	53,121.36	12.71
Grass peas	3754.12	*	*	3,232.38	71,061.33	21.98	3,330.11	51,971.51	15.61	3,870.28	58,416.42	15.09
Maize	3472.09	50994.17	14.69	3,783.43	77,976.61	20.61	3,638.58	72,193	19.84	3,713.01	70,870.89	19.09
Sorghum	4030.37	*	*	4,189.72	95,793.90	22.86	4,711.88	103,316.67	21.93	2,943.22	*	*
Faba bean	3172.63	39047.31	12.31	1,730.25	22,609.64	13.07	2,291.99	64,610.62	28.19	2,726.53	71,776.28	26.33
Field pea	4714.71	68832.89	14.6	1,037.51	14,663.03	14.13	1,633.12	25,190.03	15.42	2,534.81	35,720.88	14.09

Source: CSA, 2009, 2011, 2012, 2013

NB: No data is collected 2010 zonal basis by the agency

Seed systems can be broadly categorized into formal and informal – with the former referring to the organized seed sector including institutionalized seed producers and companies, be it private or public. The informal seed sector is non-institutionalized, encompassing seed saving, seed exchange and seed production by farmers and is often highly localized. The informal sector is yet the major source of seed of all crops in Sub-Saharan Africa (SSA), with an estimated seed share above three-quarters across eastern Africa (e.g. 80% in Kenya-Wulff *et al.*, 2006; 90% in Tanzania-Ngwediagi *et al.*, 2009; 92.5% in Uganda-Kabeere and Wulff, 2008 and 96.5% in Ethiopia-(Atilaw and Korbu, 2011). The relative shares also vary by crop with the formal share being substantially higher for maize, although estimates vary considerably across study countries. For instance, in the case of Ethiopia, seed from the formal sector is estimated to over 19% of the maize area (Alemu, 2011).

In Africa, the majority of farmers mainly get their seeds from informal channels which include farm saved seeds, seed exchanges among farmers or/and local grain/seed market. These channels contribute about 90-100 % of seed supply depending of the crop (Maredia et al. 1999). Despite the importance of this system; unlike the formal seed systems, the informal is rarely supported. Subsequently, its improvement has been very limited or nonexistent. Therefore, this has negative effects on agricultural productivity and income of farmers and more particularly to poor and marginalized farmers.

In order to ensure that quality seeds of preferred varieties are accessible to poor resources farmers, a systematic pathway combining a set of activities starting from the identification of preferred genotypes to variety demand stimulation and seed accessibility must be established from the beginning. It is very clear the crop breeding pattern and the seed system arrangement have influence on the availability and seed accessibility to farmers mostly the poor and marginalized (Jean, 2006). Therefore imposing a generic formal seed or private sector led seed systems may not be the best solution (Zerbe, 2001). An effective seed system can only operate if there is a functional informal seed sector as well as formal seed sector; both are essential and complementary to insure an effective seed security strategy (Scowcroft, 1997).

The five-year strategy of the MOA and Agricultural Transformation Agency (ATA) for the transformation of the Ethiopian Seed System recognizes three seed systems in Ethiopia (MoA and ATA, 2013) viz:

1. An informal system in which farmers engage in their own seed selection, farm-saved seed and local exchange or purchase;
2. A nascent intermediate system centered on community-based seed production with high technical support from research, NGOs and seed projects and some regulatory oversight from bureaus of agriculture; and
3. A formal system in which commercial firms and parastatal organization, working with crop breeders, multiply and distribute improved varieties to farmers.

5.1.1 Informal seed system

Informal seed supply systems are characterized by a lack of functional specialization; they are heterogeneous in space and flexible in time. These systems are traditional and informal, operating mainly at the community level through exchange mechanisms (Cromwell et al. 1992). In the informal seed system, farmers save seed and/or access seed through exchange, barter, gift, and local market as major sources of seed they use (Amsalu et al., 2014). Farmers need seed because without viable seed the survival of their household is endangered. In fact, the ways that farmers obtain seed are as old as agriculture, and most small-scale farmers in developing countries routinely save their seed from one harvest to the next. Nowadays, some 60-70 per cent of seed used by these farmers is still saved on farm. Most of the remaining seed is obtained off-farm, from local sources (Louwaars, 1994; Cromwell, 1996a).

Informal seed supply systems broadly include: (i) Farm-saved seed and farmer-to-farmer exchange, (ii) Farmers' cooperatives, (iii) Community groups, (iv) Seed growers' associations (v) Nongovernmental organizations (Cromwell et al. 1992)

As described by Teddie and Grace, (2010) the followings are the strengths and limitations in formal

seed sector:

Strengths of the informal seed sector

- ✓ There is a cheap source of seed or planting material
- ✓ Availability of resistant crops to pests and diseases
- ✓ Promoted varieties are normally adaptable to local conditions
- ✓ Varieties promoted are usually easy to store.

Factors limiting the informal seed sector

- ✓ Despite other favorable attributes, the varieties are usually low yielding and therefore negatively affect food security
- ✓ Inadequate knowledge of seed production/crop management

5.1.2 Semi-formal seed system This system includes a nascent intermediate system centered on community-based seed production. The system receives high technical support from research, NGOs and seed projects and some regulatory oversight from bureaus of agriculture (MoA and ATA, 2013). The seed distribution channel of this system includes community based seed production by organized farmers in the form of cooperatives, model farmers, and/or individual entrepreneurs. In most parts of Ethiopia, onion, pepper and tomato, potato seed tubers, sweet potato cuttings and cereals are mostly produced under the intermediate system. Farmers access to improved varieties through technology transfer and dissemination mechanisms of the research centers. This is usually followed by community-based seed production and distribution initiatives by individuals and farmers' cooperatives (Desalegn et al., 2012).

Some groups of farmers are organized into seed producer cooperatives to produce seeds for local supply. According to ISSD (2013), over thirty of such seed producer cooperatives are producing potato seed tubers and onion seeds, which are not necessarily certified (not reported). Such cooperatives and small and medium seed producers are linked with nearby agricultural research centers or universities, for technical backstopping for vegetable seed production. In eastern tigray zone cooperatives are organized to produce not only vegetables but also cereals like wheat, maize, barley common bean by the helps of Mekelle and Adigrat Universities in collaboration with ISSD project.

5.1.3 Formal seed system

In the formal seed sector, seed provision covers seed production and supply mechanisms that are governed by defined methodologies, combined stages of multiplication and quality control. Stakeholders in this sector mostly invest in research and development of new varieties, registration of varieties, seed production, processing, marketing and distribution. Seed production follows all the necessary procedures of seed certification where farmers are registered and fields are inspected for certified seed production (Teddie and Grace, 2010). Seed supplied in the formal, or organized (Camargo et al. 1989) seed sector is characterized by planned production, some form of processing, inclusion of only identified/notified varieties and a system of quality control.

In Ethiopia, there are five public (parastatal) seed enterprises, namely Ethiopian Seed Enterprise (ESE), Oromia Seed Enterprise (OSE), Amhara Seed Enterprise (ASE), South Seed Enterprise (SSE), and Somali Seed Enterprise (SoSE). However, ESE, OSE, ASE and SSE are all largely involved in grain crops, cereals, pulses and oilseeds seed production while SoSE largely deals with forage crops seeds (Amsalu et al., 2014). Thus, virtually none of these seed enterprises is involved in vegetable seed production locally or via imports, although vegetable seed production and importation is within their mandates and business objectives. This is in spite of the fact that the seed enterprises, except for SoSE, operate in favorable agro-climatic conditions known to be suitable for the production of cool season vegetable seeds (Asredie et al., 2008).

Formal seed supply systems consist of seed production by National government agencies (Ravinder et al., 2007).

(i) State government agencies
(ii) Government-assisted and other cooperatives
(iii) Multinational corporations or transnational corporations
(iv) Domestic private sector companies
    a) with their own research and development
    b) without their own R&D
(v) Joint venture companies
    a) between Multinational corporations and domestic private company
    b) between two domestic companies

There are serious concerns over the appropriateness of the varieties available in the formal seed sector, the quantity and quality of seed delivered, seed production costs and prices and timeliness of supply. More importantly, rigid government policies and regulations, poor organizational linkages and inadequate infrastructure contribute to the problems of the formal system in developing countries (Ravinder et al., 2007)

As described by Teddie and Grace, (2010) there are strengths and limitations in formal seed sector: these are indicated as follow:

Strengths in the formal seed sector

- ✓ Well established policies and regulations for variety development and seed production and quality control, which allows ease of participation in the seed industry.
- ✓ Enhanced public-private partnerships in all the components of the seed value chain.
- ✓ Well established seed distribution networks especially through agro-dealers and Agricultural Development and Marketing Corporation markets

Factors limiting potential of the formal seed sector

- ➢ Inadequate trained personnel in plant breeding and seed certification
- ➢ Inadequate funding for research, variety development and demonstrations/promotions in the public sector
- ➢ Poor seed handling by seed distributors
- ➢ Shortage of foundation seed for certified seed production especially legumes
- ➢ Lack of processing equipment in most local companies and farmer associations
- ➢ Inadequate availability of credit and reluctance of multilateral organization to invest in seed production.

6. Challenges of seed production

The following are among the most important challenges for seed production in the zone:

- ➢ Unpredictable rainfall especially shortage of rainfall in the begging of plantation and at maturity period of the crops and unnecessary rainfall at harvesting period
- ➢ Diseases and insect pests –farmers are suffering by the diseases and insects which is occurring again and again in addition farmers are unaware of the loses due to such occasion in their field
- ➢ Lack of either governmental or private seed producers that can distribute seed open the door of awareness
- ➢ There is limited understanding amongst stakeholders on the importance of adhering to standards in seed production seed multiplication business. Seed producers may be trained but it is difficult in most cases to implement the techniques. Some producers do not yet appreciate the importance of seed certification and quality control and therefore quite reluctant to incur cost of seed certification.
- ➢ Lack of postharvest handling experiences (especially at peak harvest, storage and handling of the seed)
- ➢ Lack of market for seed: even though the cooperatives are not in a position to produce more than enough seed beyond the capacity of the area but the preparation for market linkage is very low.
- ➢ Limited number of researchers engaged in improvement of varieties;
- ➢ Shortage of facilities like field vehicle and inadequate transportation for travelling to conduct field inspections, seed sampling and seed monitoring for quality control and therefore reliable transport is required for some of the areas;
- ➢ Low quality of data obtained from development agents because of farmers' traditional reluctance to reveal the amount of income from a particular enterprise; and
- ➢ Expectation of farmers for free inputs and DLS construction materials
- ➢ Scattered fields are a major challenge faced in seed multiplication. This makes field inspection expensive and time consuming.

7. Opportunities of seed production

- ➢ As the population of the zone is increasing; price of crop product also increases. So farmers need improved varieties to cover the demand of different commodities. This increased the demand of improved varieties in the market, which encourages the farmers to produce improved seed in larger amount
- ➢ Fertile land and conducive climate: farmers in the zone use inorganic fertilizer which increases the fertility of the land. With exception of scarcity of rain fail, there is good environmental condition year round.
- ➢ Increasing demand of quality seed: the interest of farmers in our zone as well as our region is increasing from time to time to use improved varieties. So, this an advantage to seed producer to sale their improved varieties.
- ➢ Source of water availability: in addition to the natural source of irrigation source from underground water is also an alternative for production of seed in off season in our zone.
- ➢ Man power with producer
- ➢ farmers are eager to produce improved varieties
- ➢ The plan of government to ward improved varieties: to achieve the plan of GDP of the country agricultural produce should be doubled. So, government gives an emphasis to the source of productivity/seed.
- ➢ The ambition of universities, research centers and experts in different sectors to help farmers in the production improved varieties.

8. Recommendations

Recommendations for improving seed production and distribution system in Eastern Tigray are as follows:

1. As there is no organization to multiply sources of planting materials, the intervention of research centers and universities is essential to strengthen the existing informal seed system and thus enable small-scale farmers to easily access improved seed at local levels. The BoA, rural development, cooperatives, and NGOs are expected to exert more concerted effort in organizing farmers at local level for improved seed production and marketing.
2. Investing in production of breeder and basic seed production. Possible interventions include increasing production capacity by subcontracting to public and private farms and investing in irrigation (changing the source of water from fuel to electrical pump) to support these farms
3. Promote greater private investment in the production of improved seed and in the establishment of independent distribution and marketing channels to farmers.
4. There is a need to strengthen the capacity of both seed growers by training on quality seed production and postharvest management as well as regulatory officers to implement improved seed inspection and certification.
5. Cooperatives need to enhance capacity on management, harvesting, threshing, storage and marketing access.
6. After the cooperatives produce improved varieties they should certify their produce to compute in inter market. So, further Investment is needed to reduce the costs of seed certification to make certified seed multiplication by small scale farmers more feasible by strengthening the decentralized certification procedures and capacity of the staff involved.
7. Continue to invest in seed-related extension programs to encourage the adoption of improved varieties and provide training to development agents on alternative varieties for different agro-ecologies especially for marginal areas.
8. Significant structural and organizational change to the seed system along these lines may help address the market and institutional failures, ultimately improving smallholder access to improved varieties.

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