

Analysis of Vegetable Seed Systems and Implications for Vegetable Development in the Humid Tropics of Ethiopia

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Abstract In Ethiopia, vegetables are important for economic, nutrition, health, smallholder farming system sustainability and attract foreign direct investment. However, advancement of the sub-sector is constrained by spatial and time gaps in seed supply systems. Based on a field survey, vegetable seed supply and distribution systems and associated policy and legal framework governing its development were assessed. Results show that different vegetable seeds types are produced and distributed through informal, semi-formal and formal channels. - Individual entrepreneurs dominate the informal system while private local and multi-national seed companies are involved in the formal systems. Preference for specific vegetables varieties is location specific. Recent enabling legal and policy frameworks have boosted investment in the sub-sector thereby increasing demand for vegetables seeds both in quantity and value. Lack of quality seeds and technological know-how remain critical bottlenecks, calling for need to strengthen quality control frameworks, extension services and linkages among supply chain actors.

Keywords Seed systems, Vegetable seed, Vegetable breeding, Dietary diversity, Micronutrient, malnutrition, Ethiopia

1. Introduction

Vegetable production is an important economic activity in Ethiopia. The production system ranges from home gardening, smallholder farming to commercial farms owned both by public parastatal and private enterprises (Zelleke and Gebremariam, 1991; Aklilu, 2000). In the context of this paper, vegetables are defined in culinary terms to include vegetables “proper”, that have fruit and leafy herbaceous parts eaten raw or cooked (i.e., lettuce, head cabbage, Ethiopian cabbage/kale, tomatoes, green and red peppers, Swiss chard, celery, green beans, etc.), root and tubers which include beetroot, carrot, potatoes, sweet potatoes, taro/*godere* and bulb crops (onion, garlic, shallot) (CSA, 2013)]. Indeed, Ethiopia is endowed with diverse agro-ecologies suitable for the production of different categories of vegetables. Tropical, sub-tropical and temperate vegetables are produced in the lowlands (<1500 meters above sea level), midlands (1500-2200 masl), and highlands (>2200 masl), respectively (FAO, 1984; EHDA, 2011; EHDA, 2012). The development of the vegetable sub-sector is one of the priority areas in the agricultural development strategy of Ethiopia (Ethiopian Investment Agency, 2008; 2012). Such emphasis

emanates from recognizing the importance of vegetable crops for food security (e.g., root and tubers, and *Enset ventricosum*), and for human nutrition and health (source of vitamins, minerals, antioxidants, dietary fiber and for having anti-carcinogenic properties). Moreover, vegetables serve as raw material for agro-industries (tomato pastecapsicum and oleoresin extraction from chili peppers). Their importance as a source of employment and foreign currency earner is increasing. Vegetables serve as suitable crops for farming systems diversification and land intensification, particularly with recent increases in the establishment of small and medium scale irrigation schemes in the country (Demissie et al., 2009; Baredo, 2012).

The area under vegetables increased from 350,600 ha with production of 2.36 million tons in 2010 to 396,510 ha with production of 4.48 million tons in 2013 for smallholder farmers (CSA, 2010; 2011; 2012; 2013). This implies that the area cultivated to vegetables increased by 13% while the production increased by 103%, between 2010 and 2013. The area under vegetable production and the quantity produced by medium and large scale commercial state and private farms also showed an increasing trend during the reference period. Similarly, export of vegetables increased from 37,210 tons valued at USD163.86 million in 2003 to 220,210 tons valued at USD 437.5 million in 2013(Ethiopian Revenue and Customs Authority, 2013), representing 709% increase in export volume and 167% in revenue.

A number of institutions support the development of the

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sub-sector. These include the Ethiopian Horticulture Development Corporation (EHDC), which has been carrying out production and marketing activities of horticultural crops since its establishment in the 1980's (Yohannes, 1989). The Ethiopian Fruit and Vegetables Marketing Enterprise (ETFRUIT) is also a parastatal trading organization established in 1980 under the EHDC to coordinate domestic and export trade of fresh fruits, vegetables, flowers, and processed horticultural products while federal and regional research institutions have the mandate to develop and release improved varieties along with recommendations on good agricultural production practices.

There has been a substantive, long-term underinvestment in research and development of the horticultural sector in Africa with particular reference to those traditional crops, which are naturally high in nutritious vitamins and minerals (Afari-Sefa *et al.*, 2012). Despite the multifaceted importance of vegetables in Ethiopia and the high priority given by policy makers for the development of the sub-sector, vegetable seed supply and distribution system is generally weak. There is limited access to information in terms of availability of varieties, seed source and quality as well as price (Tabor and Yesuf, 2012). The bulk of existing cultivated seeds are imported, often - that are not adapted to the local agro-climate. For certain vegetable crops, the informal seed system is the major source of seeds, which is triggered by poorly developed vegetable seed system in the country. To narrow this spatial, time information gaps in the vegetable seed systems while helping to devise a farming systems oriented research for development approach, a study was undertaken within the context of the Humidtropics Program. The Humidtropics Program is a CGIAR Research

Program on integrated agricultural systems for the Humid tropics. The program is being implemented in several countries across the globe including Ethiopia. The objectives of the study are to : (i) assess the vegetable seed supply and distribution systems, (ii) identify opportunities and constraints affecting target communities and beneficiaries of the Humidtropics agro-climatic zones, and (iii) assess the influence of national policy and legal framework governing vegetable seed development, production and supply chain in the country.

2. Methods

2.1. The Study Sites

The study was conducted in four major vegetable producing zones in Ethiopia. These include: West Shewa located in Oromia National Regional State, Gurage and Hadiya and Yem (special district) zones located in the Southern Nations, Nationalities and Peoples Region (SNNPR), respectively (Figure 1). Table 1 shows the list of districts (district is locally called *woreda*) and *kebeles* (farmers associations which are the lowest institutionalized administrative unit) in each of the selected zones. In total, 7 *kebeles* in 5 districts were included. The districts and *kebeles* were selected in a participatory manner through discussions with zonal and district vegetable experts, purely based on the potential they have for vegetable production. Based on local knowledge and information, districts and *kebeles* that are representative are sampled so as to shed light on vegetable production potential of the study areas and address the objectives of the study.

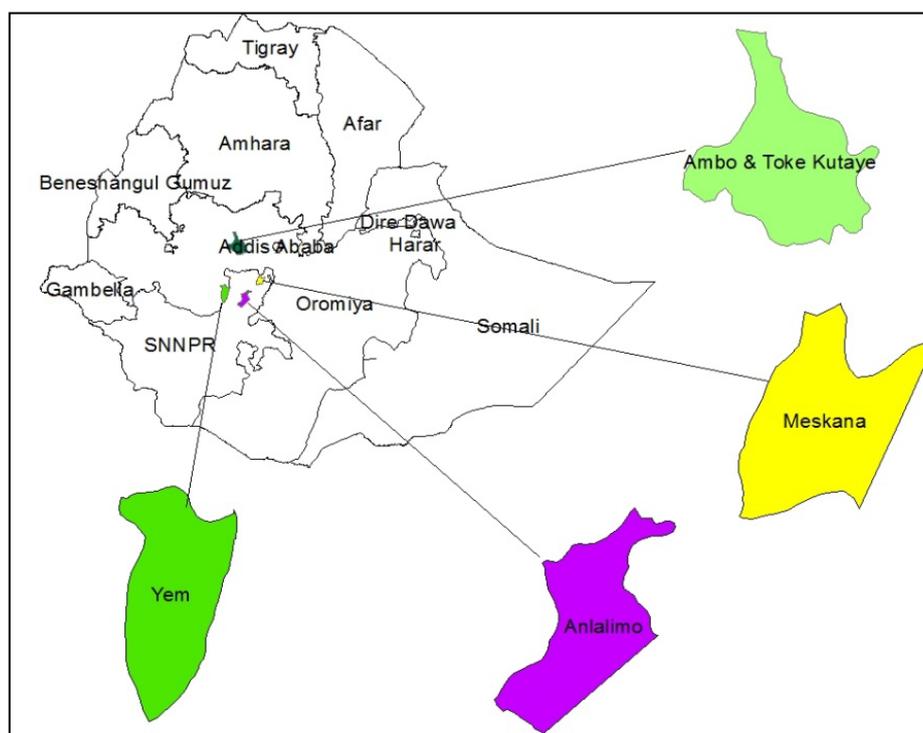


Figure 1. Map of the study sites (adapted by the study team)

Table 1. List of study sites, 2013

Region	Zone	District	Kebele*
Oromia	West Shewa	1. Ambo	1. Gosu Kora ¹
		2. Guder	2. Naga File ¹
SNNPR	Gurage	3. Meskan	3. Inseno Usme ²
			4. Yimer Wacho ²
	Yem	4. Yem	5. Tachignaw Keshele ²
			6. Sayimafo ²
	Hadiya	5. Anlemo	7. Layignaw Fonko ¹

* Kebele is the lowest administrative unit in Ethiopia; 1=sub-urban; 2=Rural

2.2. Study Approach and Data Sources

A field study survey involving a combination of qualitative and quantitative survey methods was undertaken from October to December 2013 to elicit data from representatives of various vegetable value chain actors and support service providers. Notably, horticultural experts from zonal and district bureaus of agriculture, farmers, traders, and representatives of farmers' cooperative unions provided the necessary data. Data were collected through Key Informants Interview (KII), Focus Group Discussion (FGD) and field survey. Horticulture experts at zone, district and Farmers' Training Centers were interviewed as key informants on vegetable production and marketing. In total, 12 Agricultural Development Agents (ADA, 42% female) and 12 horticulture experts (8% female) were interviewed using a checklist developed for the purpose of eliciting data. In each of the selected districts, 2 FGDs were conducted. In each village of the selected districts, one-women and one men-group participated in separate FGD sessions. In total, 150 persons (41% female) provided necessary data for this study. All discussions were guided by checklists prepared for the purpose of the study.

The data collected included type of vegetables produced, ranking of vegetables in order of importance, seed supply, vegetable seed production and marketing, and vegetable seeds handling practices of agencies. Information with regard to challenges and opportunities for improving vegetables seed supply was explored to suggest use of quality vegetable seeds on a sustainable base.

The primary data was augmented with secondary data collected from various reports that were available from zonal and district level agriculture offices of the study areas. In addition, desk reviews were made using relevant published materials and websites of national organizations such as Ministry of Agriculture (MOA), Central Statistical Agency (CSA), EHDA, Ethiopian Institute of Agricultural Research and Ethiopian Revenue and Customs Agency. Quantitative data gathered from secondary sources were presented in the results by referring to the sources, while others were used as supportive literature.

Data obtained from various sources were triangulated and checked for consistency before analysis. Primary data collected were coded and entered into Microsoft Office Excel spreadsheet and subsequently into SPSS Version 15 software. Descriptive statistics tools were used to analyze

and present the data.

3. Results and Discussion

This section is divided into two major categories: (i) vegetables seeds supply and demand which presents the formal and informal vegetable seed supply and distribution systems and the demand for seed; and (ii) policy and regulatory frameworks affecting vegetable seeds development, production, distribution and support services in Ethiopia.

3.1. Vegetable Seeds Supply and Demand

Production, marketing and distribution

To a large extent, vegetable seed demand in Ethiopia is met through commercial seed imports mainly by private seed importers and parastatal enterprises such as ETfruit and AISCO. In 2012 alone, a total of 128 tons of different vegetable seeds was imported (Table 2). This represents a more than 50% increase in volume compared to 84 tons imported in 2010 and 276% increase relative to the imported quantity in 2004 (Hassena and Desalegn, 2011; Desalegn, 2012). The increase in import of vegetable seed is attributed to expansion of irrigated vegetable production both for local consumption and export. This implies that there is a substantial demand for vegetable seeds and increase in vegetable production in Ethiopia within the reference period. As can be observed from Table 2, the bulk of the imported seed is from the Netherlands (more than 80% of the quantity and 64% of the value), followed by Italy, Germany and France. Vegetable seeds imported from Israel accounts for 20% of the value.

The most common vegetables for which imported seeds are used in the study areas include onion, carrot, tomato, cabbage, beet root and Swiss-chard. The extent of importation of leek, cauliflower, green beans and paprika is limited in the study areas. General purpose traders, farmer cooperatives, Bureau of Agriculture (BoA) (through its extension services) and NGOs are the major distributors of the imported seeds. The BoA and general purpose traders (labeled as market) were distributing more proportion of vegetable seed than cooperatives/cooperative unions in the study areas as illustrated for tomato in Figure 2. The results further show that over 80% of tomato seed supply is from the formal sector (supplied by BoA, traders, farmers' cooperative/unions and NGOs) since farm saved seed (seeds used from own saving or sourced from other farmers) was less than 20%.

The vegetable seed supply chain follows different channels depending on vegetable type. Figure 3 depicts the major functions along the supply chain, actors, and support providers for seed chain of imported vegetable varieties seeds such as cabbage, lettuce, Swiss chard, carrot, beet root, leek, cauliflower, paprika, and celery as well as large proportion of tomato and onion seeds in Ethiopia in general and in the study areas in particular.

Table 2. Quantity and value of vegetable seed imported from country of consignment in 2012

Country (Consignment)	Quantity (t)	CIF value ('000 USD)*	% of quantity	% of value
Belgium	0.08	70.75	0.06	2.1
France	3.60	64.68	2.81	1.9
Germany	3.84	74.03	3.00	2.2
India	2.58	24.24	2.02	0.7
Israel	1.16	690.87	0.91	20.5
Italy	11.94	216.31	9.34	6.4
Kenya	0.01	14.44	0.01	0.4
Netherlands	103.60	2,169.94	81.01	64.4
Niger	0.07	13.52	0.05	0.4
Spain	1.02	29.45	0.80	0.9
Thailand	0.00	0.01	-	0.0
Total	127.89	3,368.24	100.00	100.0

*CIF (Cost Insurance and Freight) is a trade term requiring the seller to arrange the carriage of goods by sea to a port of destination, and provide buyer with documents necessary to obtain the goods from the carrier.

Source: Adapted from www.erca.gov.et.com, accessed on April 19, 2014.

International and national agencies including ETFruit and AISCO are the major importers of vegetables seed in Ethiopia. The supply chain starts at the importing point. An increasing number of agro-companies are now importing and distributing commercial vegetable seeds. Since there are a number of stockiest in different parts of the country, imported seeds are easily distributed to the major vegetable producing areas and respond easily to the demand. In general, this is the only seed sector in Ethiopia that is led by market forces (Hassena and Desalegn, 2011).

Retail seed traders in the zonal capital towns and districts of the study area play a great role in buying from the importers/whole sellers in Addis Ababa and then retail at local levels. There are only 12 vegetable seed traders in the zone capital town of the study areas (7 traders in Ambo (west Shewa), 2 each in Hoesena (Hadiya) and Butajira (Gurage) and 1 in Dari (Yem).

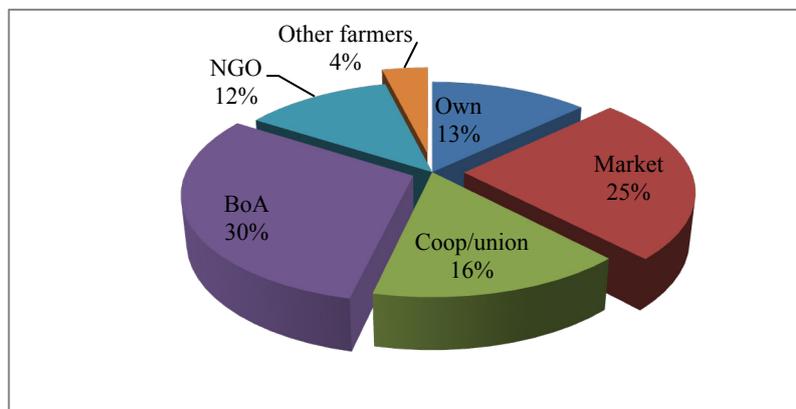
Interviews with subject matter specialists and opinion leaders in the study area revealed that some imported seeds are also distributed by farmer cooperative unions (e.g.,

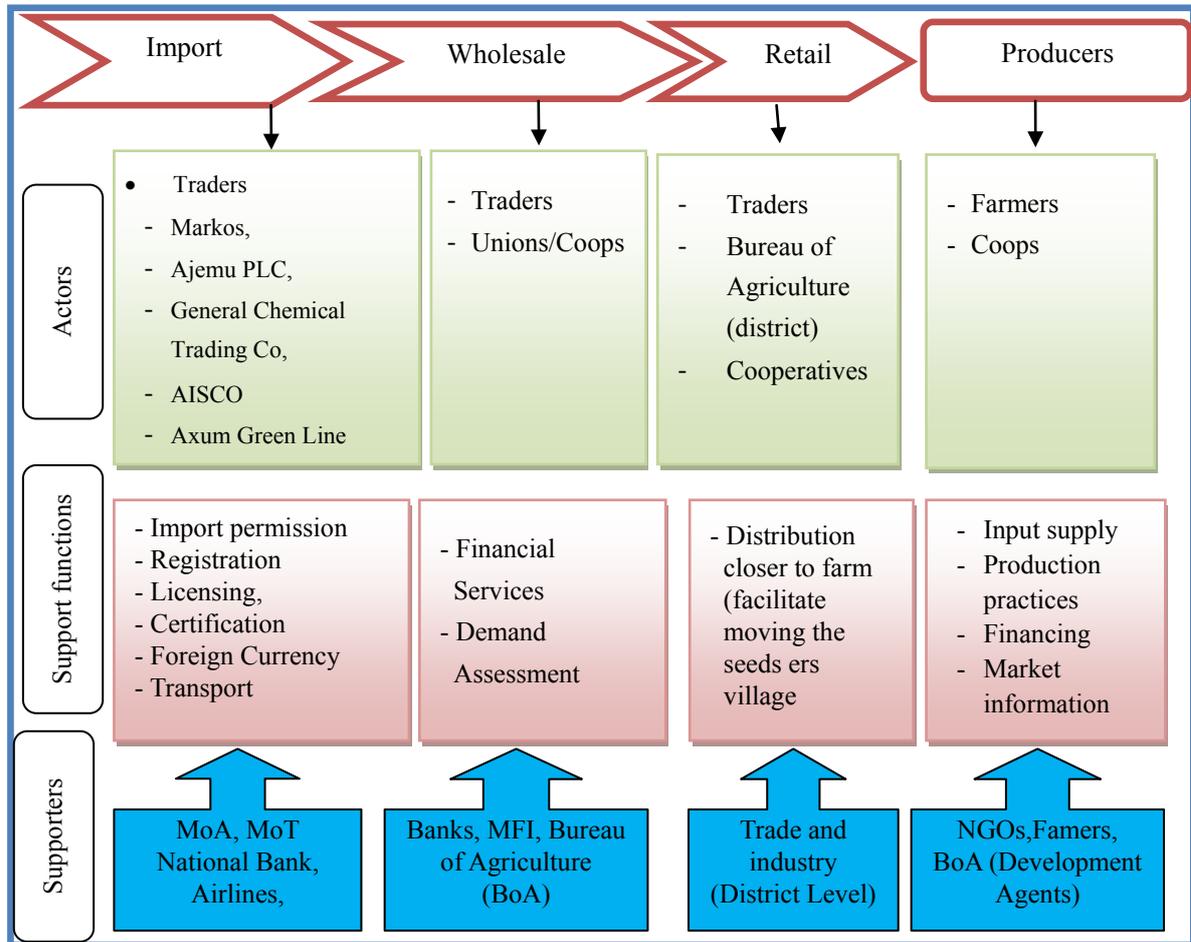
Timiret Union in Meskan district, Gurge Zone), district office of agriculture, traders serving as retailers for the seed importers, and NGOs (e.g. SOS Sahel, Kale-Hiwot, World Vision and Food for the Hunger Ethiopia). Such seeds often come in packed aluminum bags and/or cans. An informant (Ambachew Amare, personal communication, chairperson of Timiret Cooperative Union in Meskan district of Gurge zone) revealed that the union purchases tomato seed from Greenlife PLC and cabbage seeds from AISCO and then distributes to its member cooperatives and individual farmers. Farmers' cooperatives and cooperative unions are commonly found throughout Ethiopia, facilitating the supply of inputs such as vegetable seeds, fertilizers, farm tools and marketing of horticultural products, including vegetables.

Local seed distributors also play key roles in the supply chain. A recently established Farm Service Center by Gadissa Gobena Commercial Farm PLC, a private investor is supplying imported vegetables seeds like onion, cabbage, tomato and Swiss chard from European seed companies such as ProSeed and Top Harvest and distributing them in Ambo, the capital city of West Shewa Zone with the support from USAID. Although very recent, there are five other such Farm Service Centers in different parts of Oromia (<http://www.cfspethiopia.org/>). Such centers aim at supplying all agricultural inputs, including vegetable seeds in the form of a one-stop shop window for farmers.

With regard to seed production, Ethiopia follows the Organization for Economic Cooperation and Development's (OECD) seed generation (breeder seed, pre-basic, basic and certified seed) system. Research centers are largely responsible for the first three generations, while the public seed enterprises, private (often small to medium), and seed producer cooperative/unions are producing certified seed. A number of NGOs and seed development programs are also involved in community based seed production. As noted below most of vegetable seeds are imported by licensed agro-chemical importers/traders.

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

**Figure 2.** Proportion of tomato seed supplied by different sources in the study areas



MoA = Ministry of Agriculture; MoT = Ministry of Trade; Das = Development Agents

Figure 3. Seed supply chain for imported vegetable varieties, 2013

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

The following sub-sections describe types of vegetables seed systems and the role of actors under each of these systems in the context of Ethiopia in general and the study areas in particular.

Informal seed system

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. In the study areas, such means of accessing vegetable seeds is common for Ethiopian mustard (*Brassica carinata*) (locally known as *Yeabesha gomen*) that is used as vegetable at early vegetative growth stage and as oilseed when allowed to give seeds, and kale (*Brassica oleracea* var. *acephala*) locally called '*Yegurage gomen*', pumpkin and garlic, as well as to some degree for

chili pepper, sweet potato, and Irish potato. The major seed sources include own-saving, local market, other farmers, farmers' cooperatives and research centers (data not shown). Seeds distributed to farmers through this supply channel face limitations in terms of quality of planting materials, infection with diseases and viruses, consequently resulting in low yield and quality.

For kale and pumpkin, there is no record of released variety from the national research system and also no seed imports, indicating that seed production of these vegetables is based on local varieties and farmers' indigenous knowledge in genetic resources conservation, selection, production and use. Only few varieties of garlic and shallot have been released and subsequently commercialized through variety evaluation, demonstration and promotion activities of the research system. Consequently, farmers use own saved and recycle the planting materials year after year. For sweet potato and Irish potato, although there are a number of released varieties, farmers maintain their own planting materials for a considerable longer period (often for more than 5 planting seasons), once they obtain released varieties through the semi-informal or intermediary system. Farmers in the study area are also known to save their own tomato seeds, though to a limited extent. Similarly, Karanja

et al. (2012) reported that majority of farmers in Kenya and Tanzania use seeds saved from their own previous crop or received from open air markets, which have problems of purity and low mean germination rates.

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 the study area and most parts of Ethiopia, onion, pepper and tomato, potato seed tubers and sweet potato cuttings are mostly produced under the intermediate system. Although, onion and tomato seed production is increasingly expanding in Ethiopia, seeds produced do not usually go through formal quality control and certification procedures. Agricultural research centers are contributing to seed production of tomato, pepper, onion and potato seed tuber. Potato seed tuber production and distribution is also supported by UN agencies (e.g., FAO) and international NGOs such as, World Vision International and Food for the Hungry Ethiopia as well as local seed business as implemented by Integrated Seed Sector Development Ethiopia Programme.

The intermediate seed system benefits from strong support from the NARS, NGOs, and seed development programs. Crop varieties are developed and released by the NARS. Farmers access such 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. Farmers mostly access seeds of onion, chili pepper, tomato, Irish potato seed tubers, and sweet potato cuttings through this supply chain. For instance, seeds of the two common onion varieties (Adama Red and Bombay Red) are increasingly produced locally whereby research centers like Melkasa Agricultural Research Center provide technical backstopping and support for quality seed production of onion, tomato and pepper (Desalegn et al., 2012). Similarly, in West Shewa Zone, potato seed tubers producer cooperatives like Darara and Jalala Gudina as well as a number of model farmers are producing and distributing seed potato within and outside the zone. The cooperatives are supported by the Holeta Agricultural Research Center and the Integrated Seed Sector Development Ethiopia Program (ISSD), financed by the Dutch Government (ISSD, 2012). Seeds and/or planting materials produced in this system are sold mainly by the producers to the farmers directly as they are in the same area and the remaining part is sold through bureaus of agriculture and NGOs to be distributed in major vegetable production areas of the country.

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 addition, the SUPHORT Project, funded by Italian Development Cooperation, is supporting potato seed tubers and onion seed production in four districts. These are Ejere and Ilu Gelan districts in West Shewa zone of Oromia state and Bahir Dar Zuria and Fageta Lekuma districts in Amhara state of Ethiopia. The project aims at integrated horticultural development, involving capacity building, small scale irrigation schemes, participatory horticultural research and extension services and market linkages for smallholders.

Formal system

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. 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). It has also been confirmed that the technical know-how in vegetable seed production is inadequate compared to production of seeds of field crops (in both formal and informal seed sectors) (Mengistu et al., 2003; Tabor and Yesuf, 2012).

Table 3. Small to medium* seed companies engaged in vegetable seed production in Ethiopia, 2013

Seed companies/producers	Region	Zone, District	Seed produced
Bayihe Mekonnen seed producer enterprise	Amhara	West Gojam, Bure	Chili Red pepper
Jema Integrated agricultural P.L.C	Amhara	West Gojam, Mecha	Onion
TesfayeArarsa Potato Seed Producer	Oromia	West Shewa, Jeldu	Potato
GizawTulluVegetable Seed Production (AGMF)	Oromia	Southwest Shewa, Elu	Onion
Yohannes Girmay Farm	Tigray	Eastern Zone, Awilalo	Onion

*Small to medium seed companies employ 6-30 staff and has total asset amounting up to 1.5 ETB (MoT, 2011).

In addition to the public seed enterprises, there are about 30-40 emerging small to medium domestic private seed companies/producers, who mainly produce hybrid maize seeds. Only a few of such small and medium seed producers

are engaged in onion seed and potato seed tuber production and supply (Table 3). The results show that only limited companies are engaged in vegetable seed production. Based on the foregoing discussion, it was concluded that imported seed, informal and the intermediary systems are the major source of vegetable seeds used in Ethiopia.

Seed demand and pricing

The quantity of vegetable seeds demanded and used were estimated based on area covered by vegetables and the seeding rate of crops. For some vegetable seeds that are supplied through the informal system, such as kale, Ethiopian mustard, sweet pepper, sweet potato and pumpkin, there is no data on seed/seedlings demanded and used. As there is neither released variety of these vegetables from the national research system nor through imports, farmers depend on local cultivars that are available. Table 4 shows the extent of vegetable seed demand and use in the study areas. For most of the vegetables, the seed demand seems to be fairly met while there is a shortage for some crops like cabbage, onion and Swiss chard.

Costs of vegetable seeds vary significantly based on the source with imported varieties such as tomato and carrot being more expensive. In some instances, the price of seed potato seems lower than the price of ware potato, showing that farmers use inferior quality potato seed tuber (in terms of size, freedom from seed borne diseases and genetic degeneration because of viral infection) for seed (Emana and Nigusse, 2011).

Vegetable and variety preferences in the study areas

Analysis of preferred vegetables and varieties in the study areas revealed that close to 60% of the respondents preferred a local variety of kale; of course there is no improved variety for this important vegetable crop by the NARS and neither are there any seed imports. *Koshoro* and *Galilea* are preferred tomato varieties by about 66% of the respondents in the study areas. For cabbage, - Copenhagen Market constituted about a third of the preferred varieties. As was expected, Bombay Red and Adama Red are the most preferred onion varieties in the study areas. Bombay Red is said to be early maturing (about 3 months) and has a relatively shorter shelf life, suitable for local market, while Adama Red is late maturing (over 4 months) and has long shelf life, suitable for export market. Mareko Fana is the most popular chili pepper variety. *Gudane* is the most preferred Irish potato variety.

Preference for a variety of a crop depends on various attributes of the variety. The major attributes for a good tomato variety include long shelf-life as a result to thick skin, yield advantage, taste, pear shaped fruit, medium size, red colour, , no scratch or damage and fetching premium price. Although head size and perishability are important attributes in selecting cabbage varieties, the availability of seed is the overall governing factor for selecting a sole variety (Copenhagen Market) for production. Fast growth and tolerance to disease are important attributes for preferring

different local varieties of kale, even if availability of seed dictates the type to grow. Red color and pungent onion has high market demand, hence are key attributes in variety selection. Moreover, onion varieties with longer bulb size and relatively narrower width are much preferred. Availability of planting materials and medium size are important for garlic, which is quite logical in view of the fact that no organization is supplying planting materials for garlic in the country. The key factors for selecting chili pepper varieties are yield advantage, and product profiles of the variety such as deep-red color, pod size and pungent taste that have market demand and fetch high price. In general, availability of seed/planting materials determines what type of vegetable variety to grow in most cases, implying the critical shortage of options for seeds of different types of improved varieties.

Seed and variety replacement period

Although farmers are forced to buy fresh seed each cropping season because of biological necessity for vegetables like onion, cabbage, carrot, lettuce Swiss chard, beet root, and leek, the variety replacement period is quite long as old varieties are still in cultivation (Tabor and Yesuf, 2012). Worsening the situation, it was noted that even most development agents, who provide extension service support to farmers do not exactly know the names of varieties the farmers are growing. Some of the farmers also do not know by name vegetable varieties they are growing. But those who know the varieties they grow responded that *Galilea*, *Koshoro*, *Roma VF*, *Sambar Sana* and *Marglobe* are the tomato varieties they grow in different parts of the study areas. Copenhagen Market is the only cabbage variety grown across all the study areas. They also responded that varieties such as *Jalene*, *Gudane* and *Menagesha* are among the improved potato varieties they grow (some of them released over 12 years ago). *Sako* and *Shashamane* are among the local potato varieties grown in the study areas. Regarding chili pepper, Mareko Fana and Bako local are commonly grown, which are very old varieties. Bombay Red, Adama red, Red Creole and Galamso are commonly grown onion varieties.

Although farmers were not able to mention the names of carrot and beetroot varieties they grow, it was noted from the seed container that Nantes for carrot and Detriot and Detriot Nero for beetroot are the varieties being grown across all the study areas. In the case of vegetable crops such as kale (called *Kurumbo in Yem*), garlic, sweet potato, chili pepper and in some cases potato local varieties are dominantly grown in the study areas.

More than 50% of respondents in the study area replaced their vegetable varieties after 3-5 years of cultivation. Limited access to newly released vegetable varieties was mentioned as reason for less frequent replacement of imported varieties. In general, the main reasons for replacing varieties include availability of seed, yield advantage (e.g. tomato, cabbage, and potato), expectation for long shelf life (e.g. tomato and cabbage), early maturity (e.g. tomato and

onion), tolerance to diseases (e.g. tomato, beetroot and potato), taste/market preference (e.g. tomato, onion, potato, sweet potato), fetching better price (e.g. tomato, onion and sweet potato), better local adaptation (e.g. onion and beetroot).

3.2. Policies and Regulatory Frameworks

Variety development

Ethiopia has a well-established agricultural research programme, operating at federal as well as national regional states (www.eiar.gov.et). Horticulture (including vegetables, fruits and root and tuber crops) is one of the research programmes in the Ethiopian Agricultural Research System. However, the resources (budget and research staff) allocated to horticultural researches are not adequate and often much less than the resource allocated to major field crops such as cereals, pulses and oilseeds. This indicates that less emphasis is given to the sector in the research system. Even then, potato, tomato, pepper, onion, and sweet potato, in that order, are among the crops for which major emphasis is given in terms of research thrust. Only vegetables such as shallot, garlic, and paprika (*Capsicum annuum*) are considered to a limited extent. For other vegetables like head cabbage, carrot, onion, beet root, lettuce, cauliflower, spinach, and Swiss chard, packed seeds are imported by private companies mainly from European countries such as Denmark and the Netherlands. In addition to the fact that they are mostly not adapted to the local agro-climate, the generational identity (hybrid or open-pollinated) of imported seeds is seldom known. In Ethiopia, the Melkasa Agricultural Research Center, which is located 117 km southeast of Addis Ababa in the Rift Valley, is the main vegetable (tomato, pepper, onion, snap bean) research center. Debre Zeit Agricultural Research Center is working on garlic and shallot. Regional research centers (Bako, Adet, Areka, Sinana, and Hawassa), federal research center (Holeta), and Haramaya University focus more on root and tuber crops such as potato, sweet potato, enset, taro, yam, and cassava (MoA, 2012).

Principally, vegetable breeding programme in the majority of sub-Saharan African countries is practically nonexistent with capacity in the public sector having been severely reduced historically through lack of funding and privatization (Afari-Sefa *et al.*, 2012). The situation in Ethiopia is not much different with the Ethiopian Agricultural Research System (NARS) having a low research capacity and capability in the sector as a result of which vegetable seed supply is predominately dependent on imported seed (Tabor and Yesuf, 2012). As such the NARS neither has enough capacity for germplasm and variety development nor connected to other external sources and/or resources for acquiring adapted seeds of cool season vegetable crops such as kale, Ethiopian mustard, pumpkin, carrot, cabbage, beet root, lettuce, and Swiss chard (Mengistu *et al.*, 2003). This implies a low national research capacity for breeding climate resilient vegetable varieties to

cope with climate change stressors and their adaptation.

Variety release and registration

As it is true with many other sub-Saharan African countries such as Tanzania and Mali, Ethiopia does not have a separate variety release criteria/procedure for vegetable crops. Upon satisfying the requirements for Value for Cultivation and Use (VCU) test, crop varieties (including vegetable varieties) are released and registered by the National Variety Release Committee (NVRC) under the patronage of the Directorate of Animal and Plant Health Regulatory Services (APHRS) of the Ministry of Agriculture (MoA, 2012). So far there are no DUS (Distinctness, Uniformity and Stability) testing requirements for variety release and registration in the country, although MoA is in the process of introducing DUS testing as indicated in the recently revised seed law. Thus, to-date variety release is based on VCU test. The NVRC is a standing committee under the MoA entrusted which has been exercising its responsibility of variety release and registration since 1982 (Gebeyehu *et al.*, 2001). Often presided over by a breeder, members of NVRC are of diverse disciplines (breeding, crop protection, agricultural extension, socio-economics, agronomy, and food science) and constituted from research institutes, universities and MoA. The NVRC is assisted by ad hoc Technical Committees (TCs) for different crops to evaluate verification plots and performance trial data (of a minimum of 3 locations x 2 seasons) of candidate crop varieties and provide recommendations to NVRC whether the variety can be released or rejected. Members of the TCs are also mainly crop specialists consisting of breeder, agricultural extension specialist, crop protection (pathologist or entomologist), agronomist and food scientist. The NVRC deliberates twice per year to review applications for variety release and registration. The APHRS at MoA publishes annually the Crop Variety Register, in which newly released and registered varieties are described and list of previously released and registered crop varieties are included (MoA, 2012). Table 5 shows summary of released vegetable, root and tuber crops up to 2012 by category of releasing institutes, i.e., federal research centers, regional research centers, universities and private seed companies/agents.

Regional research institutes/centers and Haramaya university have played a major role in releasing sweet potato and potato varieties, while federal centers in tomato, pepper, shallot and garlic. Although the involvement of the private sector in releasing and registering commercial vegetable varieties is a very recent phenomenon in Ethiopia, its contribution is high for vegetable crops such as tomato, onion, cabbage, pepper, potato, and carrot. Overall, the regional research centers released about 36.4% of all vegetable varieties followed by the federal research centers (29.8%) and private companies (26.4%). Haramaya University contributed 7.4% of the vegetable varieties released, but this was mostly limited to sweet potato and potato.

Some international private seed companies also do register

their commercial vegetable and potato varieties in Ethiopia, often in collaboration with local partners (MOA, 2012). As a rule, such imported varieties have to be registered by the National Variety Release Committee (NVRC), under the auspices of MoA. The requirement for variety registration is one season multi-location testing if the variety is already released and in commercial production and distribution in another country. The companies apply to MoA for variety registration. The Ethiopian Institute of Agricultural Research (EIAR) and regional Agricultural Research Institutes often provide testing services within target agro-ecologies of the candidate variety. Once the variety is registered (Table 6), companies mostly import seeds of the variety from the country where it is already commercialized. On the other hand, seed potato is produced in Ethiopia.

The main challenge in vegetable variety introduction,

testing and registration, is the rapid variety replacement by the international seed companies compared to the slow process to get the variety registered in Ethiopia. By the time a variety is tested and registered in Ethiopia, it is already obsolete in the country of origin and hence does not encourage doing business. As a result, the international seed companies and/or their local agents are demanding authorization from MoA for free introduction of commercial vegetable varieties and do seed multiplication for local supply and/or export. The MoA intends considering such demand so as to promote foreign direct investment in the country. This may, however, compromise quality and result in introduction of non-adapted varieties. The outcome of which may disappoint vegetable growers and counts negatively on sustainability of such system.

Table 4. Vegetable seed demand, seed used and average price in 2012 cropping season

vegetable type	Demanded expressed for seed (kg)*	Seed actually used-rain-fed (kg)*	Seed used irrigated (kg)*	Total seed used (kg)	% seed used of the demand	Average seed price (Birr/kg)*
Tomato	305	55	250	305	100	1,750
Cabbage	292	81	199	280	96	522
Onion	23,854	15,725	7,957	23,682	99	521
Garlic	38,198	20,379	17,819	38,198	100	50
Hot pepper	1,493	1,387	106	1,493	100	63
Beetroot	4,117	2,155	1,962	4,117	100	501
Swiss-chard	252	20	60	80	32	110
Lettuce	144	60	84	144	100	138
Carrot	612	236	376	612	100	933
Potato	2,563,936	1,196,879	1,367,057	2,563,936	100	109
Leek	2,095	686	1,409	2,095	100	-

*Seed demand and use data is average of only three districts (Ambo, Meskan and Anlemo); 1Birr =20USD

Table 5. Summary of number of released vegetable, root and tuber crops in Ethiopia

Crop	Number of released variety by Variety releasing institutes				Total	%
	Federal Research Centers	Regional Research Centers	University	Private Companies/ agents		
Tomato	10	4	0	9	23	18.85
Chili pepper	7	2	0	0	9	7.38
Sweet Pepper				5	5	4.10
Onion	4	0	0	8	12	9.84
Shallot	4	0	0	0	4	3.28
Garlic	3	1	0	0	4	3.28
Lettuce	0	1	0	0	1	0.82
Cabbage	0	0	0	6	6	4.92
Ethiopian mustard	1	0	0	0	1	0.82
Carrot	0	0	0	1	1	0.82
Snap bean	1	0	0	0	1	0.82
Sweet potato	1	21	2	0	24	19.67
Cassava	0	2	0	0	2	1.64
Potato	6	13	7	3	29	23.77
Total	36	44	9	32	122	100.00
%	29.8	36.4	7.4	26.4	100.0	

Adapted from MoA (2012)

Table 6. Commercial vegetable and seed potato varieties (open pollinated – OPV, and hybrid – HV) registered in Ethiopia

Crop type	Variety	Variety type (OPV/HV)	Year registered	Company
Tomato	STH-808 (JEWEL)	HV	2012	Vibha Seeds Ethiopia PLC
	STH-805(SYNO)	HV	2012	
Tomato	Galilea	OPV	2011	Hazera Genetics LTD
	Bridget 40	OPV	2011	
	Shanty	OPV	2009	
	Irma	OPV	2009	
Tomato	Rainbow	OPV	2011	Era Agrilink PLC
Tomato	Anna F1	HV	2011	Mogno, Maria Rita
Tomato	Eden F1	HV	2011	Beck, Bunn, Teresa
Tomato	Topspin F1	HV	2011	Bejo Seed Bv-Crop grow Crop Production PLC
Tomato	Barnum	OPV	2011	Markos PLC
Onion	Rosy (SOV 111)	OPV	2012	Vibha Seeds Ethiopia PLC
Onion	Caramelo F1	HV	2012	Impact Mundial Agri Plc
	Sweet Caroline	OPV	2012	
Onion	Red Passion F1	HV	2011	Bejo Seed Bv-Crop grow Crop Production PLC
Onion	Sivan	OPV	2009	Hazera Genetics LTD
	Neptune	OPV		
Onion	Jamber F1	HV	2011	Jones Rick
Onion	Red King	OPV	2011	Markos PLC
Pepper (<i>Capsicum spp.</i>)	Capsi (SCH-902F1)	HV	2012	Vibha Seeds Ethiopia PLC
	Spicy(SCH-922F1)	HV	2012	
	SCH-925	OPV	2012	
	Supreme (SCH-942F1)	HV	2012	
Pepper (<i>Capsicum spp.</i>)	Serenade	OPV	2011	Hazera Genetics LTD
Cabbage (<i>B. oleracea</i> var. <i>capitata</i>)	Rotonda F1	HV	2011	Bejo Seed Bv-Crop grow Crop Production PLC
	Thomas F1	HV	2011	
	Lucky F1	HV	2011	
Cabbage	K500	OPV	2011	Hazera Genetics LTD
Cabbage	Oxylus F1	HV	2011	Carl Scholten
	Victoria F1	HV	2011	
Carrot	Samson	OPV	2011	Bejo Seed Bv-Crop grow Crop Production PLC
Potato	Red Scarlett	OPV	2010	HZPC Holland BV-Solagrow Plc
	Saesar	OPV	2009	
	Mondal	OPV	2009	

Source: Adapted from MoA (2012)

Seed variety release and quality control

The national seed policy of Ethiopia which was formulated in 1992 (NSIA, 1992) recognizes a healthy seed industry as an important component of agricultural development. The policy also gives due emphasis to: (i) plant genetic resources conservation, (ii) involvement of farmers in vegetable conservation endeavors as well as community-based seed production, and (iii) capacity development for germplasm and variety development, release and registration as well as capacity for seed regulatory aspects. The seed policy further acknowledges

and supports the formal seed system and the informal seed system, including community based seed production.

The revised seed law (Seed Proclamation No.782/2013) in place and associated legal frameworks are generally conducive for investment in seed production, processing, marketing and distribution of vegetable seeds, including seed import and registration of commercial varieties. However, there is limitation of technical capacity and resources in implementing the seed policy, law and regulations as well as standards and guidelines. Lack of implementation of the Ethiopia Plant Breeders Right (Proclamation No. 481/2006),

implies that there is no royalty for improved variety/seed use, unless biological factors such as use of hybrid seed dictates purchase of seed at every planting season. Discussions with a representative(s) (Daniel Mekonnen and Medmedemiaw Nekinike, personal communication) of the Directorate of Animal and Plant Health Regulatory Services (APHRS) of MoA revealed that revision of the Plant Breeders Right law and its regulation is in progress with the aim of promoting Plant Variety Protection so as to motivate investment in breeding and seed systems. The fact that Ethiopia is in the process of becoming a member of the World Trade Organization makes this optimism more likely to be realized. Even though, Ethiopia is a member of the Common Markets for Eastern and Southern Africa (Association for Strengthening Agricultural Research in Eastern and Central Africa), it has not yet harmonized its seed policy and regulations with other eastern, central and southern African countries, that will allow for free seed trade with Ethiopia. However, the Ethiopian seed policy permits importation of vegetable seeds, upon fulfilling the appropriate import permit requirements and quarantine tests. Even if Ethiopia has seed laws (Seed Proclamation 2012), Plant Protection Decree no. 56/1971 and, Plant Quarantine Regulation No. 4/1992, the implementation capacity (e.g. facilities such as laboratory, logistics, and budget) and capability (knowledge and skills gap) are very much constrained. Lack of seed quality assurance mechanism often results in disease and insect pest outbreak (Damte, 2012) and poor quality seed distribution to farmers (Desalegn et al., 2012; Tabor and Yesuf, 2012), discouraging farmers to buy and use vegetable seeds from the market.

Regarding, import permit, quarantine services and quality control of imported vegetable seeds, the standards in the country were prepared under the direction of the agricultural product standards committee and published by the Quality and Standards Authority of Ethiopia and implemented by the federal MOA and regional bureaus of agriculture (Atilaw, 2010). The Authority revised seed standards and prepared field and laboratory standards for 74 crops and issued for official implementation, including vegetables such as chili pepper, tomato and onion. The imported vegetable seed samples are often quarantined and inspected for laboratory standards by MOA upon arrival. Once they are cleared for passage through the retailing and distribution channels, such imported seeds can stay on the market for more than one season, during which there is no re-checking for quality deterioration. Thus, access to quality seed sources is limited and vegetable farmers use any available seeds they access to produce vegetables, calling for strengthening of the internal seed quality control framework. Seed laboratories that certify seeds of field crops (especially that of hybrid maize) commonly do not include vegetable seed certification whether the seed is imported or locally produced, largely due to limited capacity and resource requirements. The APHRS provides competence license for applicants qualifying to engage in seed production, processing, import and export as well as in retail of seeds, including vegetable seeds. The data

base of APHRS shows that close to twenty companies were largely involved in vegetable seed imports in 2013 (data not shown). Most of such companies are having their own local retail outlets to sale the imported seeds. However, none of these companies is engaged in vegetable seed production and processing, confirming the earlier assertion that the extent of investment in vegetable seed production and processing is very minimal within the country.

4. Conclusions and Recommendations

There is a general increasing trend for development of the horticultural sub-sector partly due to increasing demand emanating from increasing population, urbanization, increased awareness of the nutritional and health importance of horticultural crops like vegetables and fruits. This has triggered increased demand for good quality seed. The demand for agro-processing and export of vegetables is also quite substantial. Ethiopia has diverse agro-ecologies for production of cool season vegetables like cabbage, onion, carrot, beetroot, Swiss chard, kale and Ethiopian mustard and warm season vegetables like tomato, chili and sweet pepper as well as green beans. The high demand for horticultural products, availability of suitable agro-ecology, and increasing irrigation schemes development focusing on vegetable production, have resulted in increased demand for quality seeds of improved varieties of various vegetable crops so as to serve further boost in local production, albeit with increased investment.

Increasing number of international and local private agents are introducing, getting tested and registered commercial vegetable varieties in Ethiopia, which, in turn, is increasing the chance of boosting vegetable production using high yielding improved varieties, seeds of which can easily be imported and/or produced in the country. Increasing number of agro-companies are importing and distributing commercial vegetable seeds in the country. Since there are a number of stockiest in different parts of the country, the imported seed is easily distributed to the major vegetable producing areas and respond easily to the vegetable seed demand. However, good quality seed is still lacking due different factors: limited policy implementation capacity (e.g., facilities such as laboratory, logistics, and budget) and capability (knowledge and skill gap). Similarly, there is limited capacity of public sector vegetable breeding program to develop and release seeds that are more adapted to specific agro-ecologies in the country as well as for effective vegetable seed production and distribution, extension services and weak linkages and integration among value chain actors. A number of opportunities and constraints influenced the development of vegetable seed system and vegetable production and marketing in Ethiopia. Fully exploiting the opportunities may result in minimizing the underlying challenges. The findings of the study have the following implications to enhance the supply of quality vegetable seed and substantially contribute to increased

productivity.

A similar scoping study has assessed opportunities and constraints for future economic development of sustainable vegetable seed businesses in eastern and southern Africa (Lenné *et al.*, 2005). The results indicated that domestic vegetable production is limited by poor access to improved varieties, quality seed and technical assistance, among others.

On the basis of the analysis from the study, the following recommendations are proffered. There is an urgent collective need by the Ethiopian government, development agents and the private sector to:

i. Strengthen the vegetable seed quality control and assurance system to ensure inspection and certification of vegetable seeds. This calls for developing the capacity and capability of the seed regulatory systems of the MoA and regional bureaus of agriculture, including seed laboratories and strengthen the quarantine facilities.

ii. Increase research capacity and capability for germplasm and variety development of major vegetable crops. Neglected traditional vegetables such as kale and Ethiopian mustard need to be given due attention in terms of germplasm and variety development and seed production.

iii. Enhance both public and private engagement in vegetable technology generation, seed multiplication, marketing and distribution in order to fully exploit the climatic and agro-ecological factors suitable for vegetable production in the country and meet the export demand for fresh vegetables. There is special need to develop vegetable sector specific guidelines for the development of the seed supply chain in Ethiopia. This calls for transformation of the seed supply system from informal to more formal type through system establishment and capacity development.

iv. Promote public-private partnership among NARS, international vegetable research and development centers, and commercial vegetable breeding and seed companies in order to access germplasm and commercial varieties for such important vegetables like kale, pumpkin, cabbage, cauliflower, carrot, beetroot and Swiss chard.

v. Develop clear regulation and directives for registration of commercial varieties by private investors so that more number of varieties of different vegetable crops can be introduced and produced in the country and prepare clear guidelines for the importation and distribution of quality vegetable seed to meet demand adequately.

vi. Increase public and private sector investment in irrigated vegetable production to increase the supply of vegetable, which in turn will increase the demand for vegetable seed.

An overarching recommendation and critical determinant of success is the need to develop well-coordinated and integrated value chains for key vegetables in the country, where seed delivery is an integral component.

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