Characterization and Assessment of Vegetable Production and Marketing Systems in the Humid Tropics of Ethiopia

Bezabih Emana
HEDBEZ Business & Consultancy PLC, Addis Ababa, Ethiopia

Victor Afari-Sefa and **Fekadu F. Dinssa**
The World Vegetable Center (AVRDC), Eastern and Southern Africa, Arusha, Tanzania

Amsalu Ayana, Tesfaye Balemi and **Milkessa Temesgen**
HEDBEZ Business & Consultancy PLC, Addis Ababa, Ethiopia

Abstract

Vegetables are sources of vitamins, minerals and income for those involved in production and marketing. Having first-hand information about vegetable production and marketing system is essential to devise appropriate strategies aimed at enhancing vegetable value chain development. It was in line with this view that a study was conducted to characterize vegetable production and marketing systems at selected sites in the humid tropics of Ethiopia. Data were collected using participatory primary survey techniques augmented with secondary data. While the area cultivated to vegetables has been increasing over the years due to increasing consumer demand, average yields are far below potential. Major vegetable production and marketing constraints include: lack of access to improved variety seeds, high postharvest losses, lack of reliable market information systems, low bargaining power of farmers, low technological know-how for value chain development and upgrading, all indicating critical areas of intervention. Increasing public awareness the nutritional importance of vegetables will critically help in reducing malnutrition while increasing smallholder household income.

Keywords: vegetable value chains, integrated farming system, farming systems diversification, vegetable productivity, vegetable marketing, Ethiopia
JEL: D01, D13, Q10, Q11, Q12, Q13, Q15

1 Introduction

Various types of vegetable crops are grown in Ethiopia under rain-fed and/or irrigation systems (ALEMAYEHU et al., 2010). The major economically important vegetables include hot and sweet peppers (*Capsicum spp.*), Ethiopian mustard/kale (*Brassica carinata*), onion (*Allium cepa*), tomato (*Solanum lycopersicum*), chili (*C. chinense*), carrot (*Daucus carota*), garlic (*A. sativum*) and cabbage (*B. oleracea* var. c*apitata*). According to the Ethiopian Investment Agency (2012), green beans (*Phaseolus* spp.) and peas (*Pisum sativum*), okra (*Abelmoschus spp.*), asparagus (*Asparagus officinalis*), cauliflower (*B. oleracea* var. *botrytis*), broccoli (*B. oleracea* var. *italica*), celery (*Apium graveolens* L.), eggplant (*S. melongena*) and cucumbers (*Cucumis sativus*) have also recently emerged as important export vegetables.

In 2013 for example, Ethiopia exported 220,213 tons of vegetables and generated USD 438 million (ETHIOPIAN REVENUE AND CUSTOMS AUTHORITY, 2013). Ethiopia has favorable climate and edaphic conditions for the production of tropical, sub-tropical and temperate vegetables in the lowlands (<1500 meters above sea level), midlands (1500-2200), and highlands (>2200), respectively (FAO, 1984; EHDA, 2011, 2012). Commercial production of horticultural crops, including vegetables, has also been increasing in recent years because of expansion of state farms (e.g., Ethiopian Horticulture Development Corporation) and increasing private investment in the sector by national and international entrepreneurs (EHDA, 2011, 2012). Commercial vegetable production is concentrated in the Rift Valley areas of Ethiopia, primarily due to availability of irrigation facility, accessibility and closeness to agro-processing industries (ALEMAYEHU et al., 2010). The Ethiopian Horticulture Development Corporation has been carrying out production and marketing activities of horticultural crops since its establishment in 1980 (AGONAFIR, 1991). The Ethiopian Fruit- and Vegetables Marketing Enterprise (ETFRUIT) is a parastatal trading organization established in April 1980 under the Horticulture Development Corporation to deal with domestic and export trade of fresh fruits, vegetables, flowers, and processed horticultural products. Relatively, smaller quantities are produced in the highlands, eastern Ethiopia and some isolated parts of northern Ethiopia. Warm season vegetables such as tomato, hot pepper and snap beans (*Phaseolus* spp.) are produced in hot semi-arid areas both under rain-fed conditions and irrigation (particularly in the Rift Valley), while the highland offers favorable growing conditions for the production of cool season vegetables such as Ethiopian mustard, cabbage, potato, garlic, onion, shallot (*A. cepa* var. *aggregatum*), carrot and beetroot (AKLILU, 2000; EHDA, 2011, 2012).

Vegetable production is an important economic activity in Ethiopia, ranging from smallholder farming to large scale commercial farms (ZELLEKE and GEBREMARIAM, 1991). While smallholders usually use the largest part of their vegetable produce for

home consumption and sell the surplus, the commercial state and private farms produce solely for market. According to CSA (2012), about 2,710 million tons of vegetables, root and tubers were produced on 541,000 ha, creating means of livelihood for more than 1 million households in 2010/2011. The cultivated crop production area increased by 26%, while the production volume increased by 73% between 2011 and 2013 (CSA, 2013).

In recent years, awareness of the nutritional and health benefits of vegetables in Ethiopia has been increasing due to public health advocacy on the role of vegetables in human nutrition and health through its provision of antioxidants such as vitamin A, C and E that are important in neutralizing free radicals (oxidants) known to cause cancer, cataracts, heart disease, hypertension, stroke and diabetes (DEMISSIE et al., 2009; TABOR and YESUF, 2012) and partly because of the rising prices of livestock products such as meat, milk and eggs, which traditionally forms a major component of most Ethiopian diets. As such the increasing consumption of vegetables helps to fight hidden hunger, malnutrition. Vegetables are also used as a source of raw material for the local processing industry. Processed products such as tomato paste, tomato juice, oleoresin and ground spice of hot pepper/chili (*Capsicumspp.)* are produced for exports making a significant contribution to the national economy (AKLILU, 2000; BAREDO, 2013).

Increased national and growing regional demand for vegetables has triggered commercial production and boosted private investment in the sector by both national and international entrepreneurs (EHDA, 2011, 2012), increased exports to Djibouti, Somalia, South Sudan, the Sudan, the Middle East and European markets (TABOR and YESUF, 2012). This partially affirms government's policy of increasing productivity of high value crops with the aim of increasing household income and improving nutrition. It has been noted that, increasing consumption of vegetables and fruits contributes to reducing hidden hunger (i.e. micronutrient deficiency), which is related to health problem caused by a lack of essential vitamins and minerals such as vitamin A, zinc, iron, and iodine in the diet (ADISH, 2012).

Despite the increasing importance of vegetables in Ethiopia, there is inadequate knowledge on improved production systems and marketing, especially in the humid tropics that was the target area of the present study. With increasing population and declining land size, a better understanding of the production system, marketing channels and endowed opportunities for growth will go a long way to contribute to improve return on investment for value chain actors in the sub-sector. Against this backdrop, the specific objectives of this paper are to: (i) characterize vegetable production system and assess productivity in the study zones; (ii) analyze the structure, conduct and performance of vegetables marketing systems in the study area; and

(iii) identify vegetable production and marketing constraints and opportunities and suggest entry points for future interventions and investment in the sector. The study is part of the CGIAR research program on integrated systems for the humid tropics, which aims at reducing poverty, increasing food security, improving nutrition and health and sustainable management of natural resources. In Ethiopia the study is implemented in the southwestern highlands, having humid tropics climate (ALEMAYEHU et al., 2010).

2 Methods

2.1 The Study Sites

The study was conducted in three zones and one special district[1] which are among the major vegetable producing baskets in Ethiopia. According to CSA (2012), about 702, 201 smallholder farmers produced 99,368 tons of vegetables on 50,846 ha of land. West Shewa zone is located in Oromia National Regional State while Gurage and Hadiya zones and Yem-Special district are located in the Southern Nations, Nationalities and Peoples Region (SNNPR) (Figure 1). Table 1 shows the list of districts and kebeles (kebele is the lowest administrative unit in the government administrative structure) in each of the selected zones. About 90% of the kebeles in the sample districts grow vegetables. A total of seven kebeles from five districts were surveyed. The districts and kebeles were selected in a participatory manner through discussions with zonal and district vegetable experts to ensure that the samples were fairly representative with respect to the vegetable production potential while addressing the study objectives.

Table 1. List of study sites

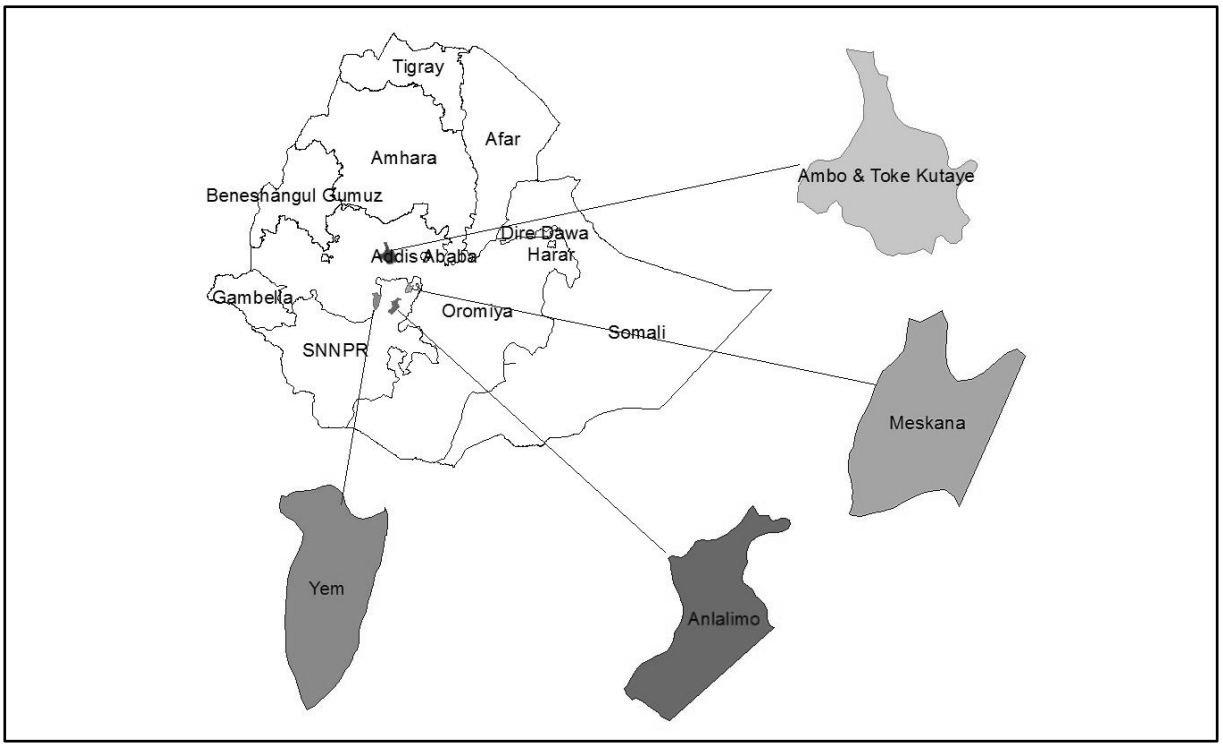
Region	**Zone**	**District**	***Kebele****
Oromia	West Shewa	Ambo	Gosu-Kora[1]
		Toke Kutaye	Naga File[1]
SNNPR	Gurage	Meskan	Inseno Usme[2]
			Yimer-wacho[2]
	Yem-Special District	Yem-Special District	Tachignaw Keshele[2]
			Sayimafo[2]
	Hadiya	Anlemo	Layignaw-fonko[1]

* Kebele is the lowest administrative unit in Ethiopia; [1]suburban; [2]rural kebele included

Source: field survey by authors (2013)

[1] In Ethiopia, zones are administrative structures accountable to the regional state while districts are responsible to zones. Special districts are directly accountable to regional state though they do not qualify to have zonal status.

Figure 1. Map of the study sites in the humid tropics of Ethiopia



Source*:* adapted by authors (2013)

2.2 Study Approach and Data Sources

A field study involving a combination of qualitative and quantitative survey methods was undertaken from October to December 2013 to elicit data from various vegetable value chain actors, notably horticultural experts from the sector ministry, farmers, traders and representatives of cooperative unions. The pooled primary data was augmented with secondary data collected from various publications and reports that were available from zonal and district agriculture offices, literature and national institutions such as CSA, EHDA, research centers, among others. Primary data were collected through key informant interviews (KII), focus group discussions (FGD) and field observations. The KII and FRG respondents were purposely selected agronomists from district and zonal bureau of agriculture, representatives from the Cooperative Promotion Offices, leaders of cooperative unions and traders dealing with vegetable products at the study locale.

Horticulture experts at zone, district and Farmers' Training Centers (FTCs) were interviewed as key informants on their vegetable production and marketing experiences. A total of 12 development agents (DAs) (42% female) and 12 horticulture experts (8% female) were interviewed using a checklist developed for the purpose of eliciting data.

Development agents are kebele level extension agents with diploma level qualification in agriculture, including horticulture. In each of the selected districts, 2 FGDs were conducted. In each village of the selected district one-women and one men's-group participated in separate discussion sessions. In total, 118 farmers (45% female) participated in the FGD. The data collected included: type of vegetables produced, ranking of vegetables in order of importance, area under production, nature of production system, volumes produced, types and sources of inputs, purpose of production, amount of vegetables marketed, mapping of vegetable value chains and actors, marketing channels and costs, sales prices, and constraints and opportunities in the value chain. The data collected were coded and entered into Excel spreadsheets and SPSS Version 20 statistical software package. Data obtained from various sources were also triangulated, checked for consistency and analyzed. Descriptive statistics were used to analyze and present the data.

3 Results and Discussion

3.1 Vegetable Farming System and Variety Preference

In the study local, vegetable production is integrated into mixed farming system where different types of crops are produced on the same plot of land or in sequence with other crops in rotation. Depending on availability of land and crop suitability for intercropping, some vegetables are grown either as sole or intercropped with other vegetables or cereals. Vegetables such as tomato, beetroot, Swiss-chard, lettuce, carrot, cabbage, onion, garlic, kale, sweet potato and hot pepper are dominantly grown as sole crop whereas Ethiopian mustard and pumpkin are dominantly intercropped with maize and other annual or perennial crops, and with Irish potato especially in homesteads. Integrating vegetable production in a farming system has contributes substancially to food and nutrition security as the vegetables complement stable foods for a balanced diet by providing vitamins and minerals. Due to such benefits, some projects such as "better potato for better life" project are supported by USAID and implemented by the International Potato Center (CIP) in Ethiopia.

Vegetables are usually grown in two seasons, namely in the wet season (locally known as *meher* season) using rainfall with supplemental irrigation or under full irrigation during the dry season. Vegetables such as pumpkin, Ethiopian mustard, hot pepper, sweet potato, and some others are predominantly grown under rain-fed conditions. Irrigated farming is considered costly due to the intensive use and high cost of diesel fuel for pumping water, agro-chemicals and hired labour costs. Thus, choice of crop selected for irrigation is critical. Results from the focus group discussions indicate that green beans, Irish potato, kale, cabbage, tomato and onion have high market value to

offset high cost of production under irrigated farming systems. Irrigated farming also enables the farmers to align harvest time to meet off-season higher market demand, when farm-gate prices are much higher. During the rainy season, farmers follow a similar strategy by ensuring that the timing of planting and harvesting coincides with periods of higher consumer demand and competitive farm-gate prices, thereby avoiding periods of peak market gluts. In Ethiopia vegetable consumption often increases during the Christian fasting period, when livestock products are not consumed and the demand for pulses and vegetables are high. Vegetable growers often align their planting time so that harvesting will coincide with the fasting period. Producing under irrigation also enables the farmers schedule production pattern to avoid periods of high pest and disease infestation.

Depending on the agro-ecology and resource availability, the type of vegetables grown in the different districts of Ethiopia varies. The results of the study are thus consistent with the findings of other authors (see for example, HAJI, 2007) and confirm that there is both vegetable integration as well as diversification in the study districts. Certain vegetable types are dominant in specific districts. To this end, results from the subjective ranking assessment of the dominance of vegetable types by respondents from the various farm households and expert opinions were consistent. In terms of geographic distribution, tomato, onion, cabbage and Irish potato are among the top ranking vegetables while kale is dominant in Gurage and Hadiya zones in general, and in Meskan and Anlemo districts in particular (Table 2).

Table 2. Rank of vegetables by relative dominance in the farming system

	Vegetable production dominance rank by district*				
Vegetables	**Guder**	**Ambo**	**Yem-Special District**	**Mesken**	**Anlemo**
Tomato	1	2	1	1	3
Sweet potato	4				
Cabbage	3	3	4	4	2
Onion	2	1		2	4
Hot pepper	5			3	
Beet root		4	3	5	5
Irish potato		5	2	3	1
Garlic		2	5		
Carrot			4		
Ethiopian mustard			1	2	1

*,1 indicates most widely grown vegetable

Source: field survey by authors (2013)

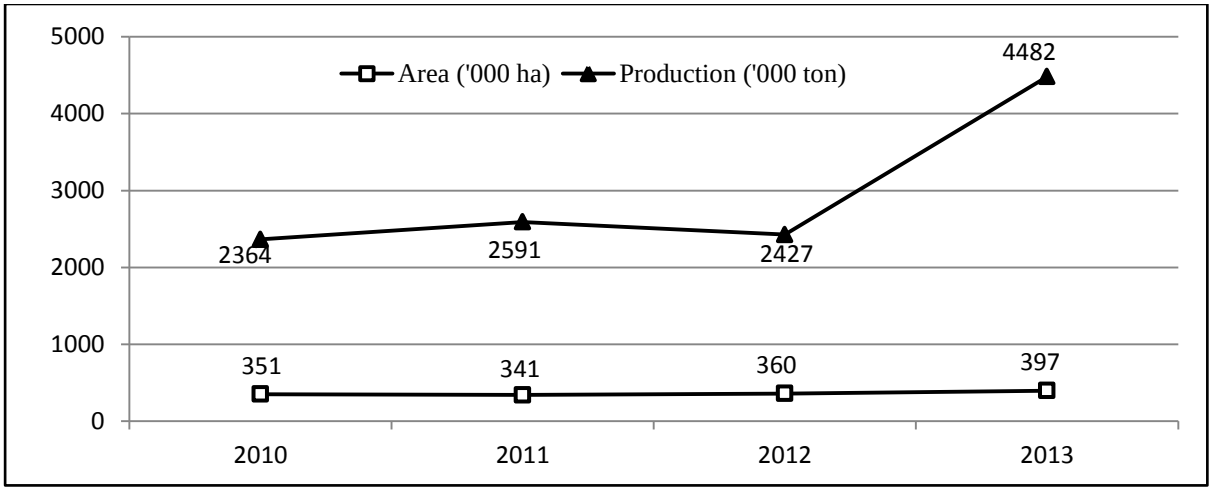
A preference assessment for varieties indicated that, there is preference for specific varieties due to differences in key identified attributes. The major attributes for tomato include low perishability, high yield, taste and ability to attract a premium price. Although head size and head compactness are important attributes in selecting cabbage varieties, availability of seed is the overall governing factor for preferring a variety such as 'Copenhagen' as the sole variety for production in some areas. Fast growth and tolerance to diseases are important attributes for preferring different local varieties of Ethiopian mustard. However, in most cases availability of seed dictates the type of varieties selected for production. Color, early maturity and market demand are the key attributes of best onion varieties. Availability of planting materials and clove size govern selection of garlic cultivars, which is quite logical in the sense that there are no formal sources of garlic planting materials in Ethiopia. Yield, color, pod size and market demand are on the other hand the most important criteria in selecting hot pepper varieties. Notwithstanding the role of the specific attributes determining varietal selection, availability of seed/planting materials dictates what type of vegetable variety to grow in most cases, implying the critical shortage of improved seed and/or planting material supply at required time and space.

3.2 Production Area and Yield Estimates of Vegetables

According to CSA, the area under all vegetables grown by smallholder farmers increased from 351,000 ha in 2010 to about 397,000 ha in 2013 in Ethiopia, representing an increase of about 16%. Total production also increased by 87.5%, from about 2.4 million tons in 2010 to about 4.5 million tons in 2013 (Figure 2). The aggregated average yield of all vegetables is used as the indicative aggregate productivity of all vegetables, though the yield of individual crops are notably very different. The result showed a staggering trend between 2010 and 2012, increasing from 6.7 tons/ha in 2010 to 7.6 tons/ha in 2011 and then declined to 6.4 tons/ha in 2012 and finally increased to 11.3 tons/ha in 2013. For non-root type vegetables, the average yield over the four year period were 4.0 ton/ha in 2010, 5.3 ton/ha in 2011, 4.7 ton/ha in 2012 and 4.4 ton/ha in 2013, showing a relatively stagnant and low yield trend over the periods.

According to the survey results, the total area allocated for vegetable production for all 4 study zones during the 2012 production year was 85,827 ha. The largest area was allocated to vegetables to the West Shewa Zone followed by Gurage Zone (Table 3). On average, about 35% of the total area under vegetable production in the zones is irrigated. The proportion of irrigated vegetable land ranged from 23% in Gurage Zone to 55% in Yem-Special District.

Figure 2. Trend in aggregate cultivated area and production of vegetables in Ethiopia



Source*:* derived from CSA data of the respective years

Table 3. Total land allocated to vegetables and irrigated area (ha) in the study zones

Zone	Total vegetable area	Irrigated area	% irrigated
West Shewa	43,695	19,877	45.5
Yem-Special District	901	496	55.0
Gurage	37,192	8,452	22.7
Hadiya	4,039	1,007	24.9
Total	85,827	29,832	34.8

Source: calculations based on data from field survey by authors (2013)

Table 4 shows the land allocated to different vegetables in the study zones under rain-fed and irrigated production systems for the 2012 production season. In West Shewa Zone, vegetables such as potato, onion, cabbage, Ethiopian mustard and garlic are dominant vegetables produced under rain-fed conditions, occupying 72% of the total area of vegetable production. In Gurage Zone, Irish potato alone accounted for 78% of vegetables grown under rain-fed conditions. Irish potato and sweet potato occupied the largest share (77%) of area allocated for rain-fed vegetable production in Yem special district. In Hadiya zone, cabbage, beetroot and carrot together accounted for 69% of the total area allocated for rain-fed vegetable production. In West Shewa Zone, the largest area (74%) of irrigated vegetable land was allocated for potato, onion and tomato production. In Gurage Zone, the largest area of irrigated vegetable land was

allocated for Ethiopian mustard, onion, tomato, and potato production, altogether covering 79% of the total area allocated for all vegetables under irrigation. In Hadiya zone, tomato, cabbage and onion together shared 64% of the total land allocated for vegetables production under irrigation. In all the four zones, cassava (root is consumed as a side dish similar to potato) and pumpkin were not grown under irrigation, as revenues accrued from their sales are insufficient to offset the high investment cost for irrigation.

Table 4. Area under vegetable production in the four study zones in 2012

Vegetable type	Area by zone or district (000' ha)							% of study districts	
	West Shewa	Yem	Gurage	Hadiya	Total	Total irrigated	% irrigated	Total area	Irrigated
Tomato	3.98	0.08	1.68	1.24	6.98	5.31	76.1	39.5	44.5
Cabbage	3.83	0.03	0.94	1.49	6.29	2.33	37.1	28.7	55.5
Ethiopian mustard	–	0.06	3.68	–	3.75	2.06	55.1	39.5	56.2
Onion	7.05	0.02	2.07	0.95	10.08	5.45	54.1	17.6	22.3
Garlic	2.87	0.03	1.34	0.25	4.49	1.39	30.9	11.6	14.6
Hot pepper	1.98	0.00	8.03	–	10.02	1.34	13.4	26.2	15.9
Sweet pepper	–	–	–	0.30	0.30	0.30	100.0	–	–
Beet root	2.24	0.04	0.34	1.18	3.80	1.59	42.0	20.6	27.3
Swiss-chard	0.15	–	0.15	0.24	0.54	0.22	40.0	20.6	49.1
Lettuce	0.17	–	0.06	–	0.23	0.16	69.6	5.2	4.4
Carrot	1.95	0.04	0.50	0.84	3.32	1.23	37.1	21.8	30.5
Cassava	–	–	0.10	–	0.10	–	–	–	–
Ethiopian mustard	3.42	0.03	0.03	–	3.47	0.86	24.6	1.3	–
Pumpkin	–	–	0.12	–	0.43	–	–	100.0	
Sweet potato	1.76	0.15	0.68	0.07	2.56	0.85	33.2	16.7	16.7
Potato	14.31	0.44	17.71	0.22	22.63	9.73	43.0	11.3	16.3
Total	**43.70**	**0.90**	**37.19**	**4.04**	**85.83**	**29.83**	**34.8**	**18.6**	**31.2**

Source: derived based on 2013 survey data from agricultural offices of the respective zones and districts

Out of the 46 districts in the study zones (20 in West Shewa, 1 in Yem-Special District, 15 in Gurage and 10 in Hadiya), the five studied districts account for about 19% of the total vegetable areas of which 31% is under irrigation. This shows that the study districts are potential areas for vegetable production within the humid tropics of Ethiopia. More importantly, over one-fifth of the most important vegetables such as

tomato, cabbage, Ethiopian mustard, hot pepper, beetroots and Swiss-chard largely produced for market are supplied from the study districts (Table 4).

Analysis of FGDs indicates that almost all farmers in all the study districts are engaged in the production of major vegetables of economic importance. The area allocated by households for the production of these crops varies and is often very small. The average household level area allocated for vegetable production in the five districts ranges from 0.11 ha in Meskan to 0.19 ha in Ambo. For example, in Toke Kutaye district, an average of 0.38 ha of land was allocated for tomato production per household, which is much higher than the area allocated to other vegetables. Similarly, only a very small land size is allocated for production of beetroot as well as hot pepper. In Ambo district, onion production is most common, occupying an average of 0.5 ha of land per household whereas only 0.25 ha was allocated for each of tomato, cabbage and garlic.

According to information obtained from the Zonal Agriculture Offices of the study locale, about 1.28 million tons of vegetable crops were produced during the 2012 production year, representing about 50% of the national data reported by CSA for the same year. The zonal/district office's data on production was extrapolated based on data from yield estimates obtained from the respective zones and area under production. The data indicates that about 0.5 million tons (39%) of vegetable production was under irrigated farming (Table 5). For the study zones as a whole, about 25% of the irrigated vegetable produce comes from the study districts. The major share of vegetable production (70%) in the study districts is produced under irrigated conditions. However, there is variation among the zones and districts in terms of irrigation potential and use. The total production in Gurage zone was 102.6, 13.4 and 12 times higher than the amount produced in Yem-Special District, Hadiya and West Shewa Zones, respectively. In West Shewa Zone, vegetables such as potato, onion, Ethiopian mustard, cabbage and beetroot together make the largest share (85%) of the total vegetables under the rain-fed system whereas the amount of Swiss-chard, carrot and lettuce is only 1% of the total production.

Irish potato is the most important vegetable produced in all of the zones. Ethiopian mustard/kale is the second most important vegetable produced in Gurage zone. The result reflect crop adoption patterns that are based on relative comparative advantage of the different vegetables in the various agro-climatic zones as well as the production and food consumption habits of the associated populace at each location.

Table 5. Vegetable production in the study zones and relative share of the sampled districts in 2012

Vegetable type	Total vegetable production by zone or district(000' ton)							% of study districts	
	West Shewa	Yem	Gurage	Hadiya	Total	Total irrigated	% irrigated	Total production	Production from irrigated area
Tomato	17.57	0.96	51.72	27.36	97.61	83.00	85	36	36
Cabbage	13.40	0.33	22.59	30.05	66.36	34.14	51	37	52
Kale	-	0.48	116.59	-	117.06	53.18	45	25	43
Onion	40.10	0.23	53.62	14.29	108.26	88.79	82	20	18
Garlic	5.49	0.36	20.59	3.47	29.91	12.47	42	10	12
Hot pepper	3.19	-	14.95	-	18.14	9.05	50	26	27
Sweet Pepper	-	-	-	0.28	0.28	0.28	100	-	-
Beet root	6.85	0.37	7.23	22.01	36.46	14.34	39	27	42
Swiss-chard	0.24	-	2.90	4.49	7.63	1.79	23	24	98
Lettuce	0.87	-	1.18	-	2.05	1.02	50	10	10
Carrot	2.64	0.34	12.63	16.03	31.64	16.81	53	26	29
Cassava	-	-	1.73	-	1.73	-	-	-	-
Ethiopian mustard	9.29	0.01	0.03	-	9.33	2.76	30	-	-
Pumpkin	-	-	1.68	-	1.68	-	-	1	
Sweet potato	1.49	0.76	18.10	1.61	21.97	5.81	26	11	12
Potato	155.24	5.45	572.13	5.15	737.97	178.86	24	4	12
Total	256.36	9.31	897.68	124.74	1,288.08	502.29	**39**	**14**	**25**

Source: agricultural offices of the respective zones and district

The yields under rain-fed and irrigated conditions of the most common vegetables were estimated (Table 6) by the farming communities involved in the focus group discussions. The yield depends on the production season and the vegetable type. For example, onion, garlic, hot pepper, beetroot, carrot, sweet potato and potato registered higher yields under irrigation production compared to rain-fed production. On the other hand, tomato, Swiss chard and lettuce registered lower yield under irrigation than under rain-fed in similar farming system. According to the respondent farmers, the divergent results could be attributed to the differences in susceptibility to diseases during the rainy season and to insect pests and heat during the dry season. The average yield of the vegetables in the study districts is more skewed to the right as compared to average yields reported by the district offices. This could be attributed to either the relatively good potential of the study kebeles or perhaps estimation bias by horti-cultural experts at the district level.

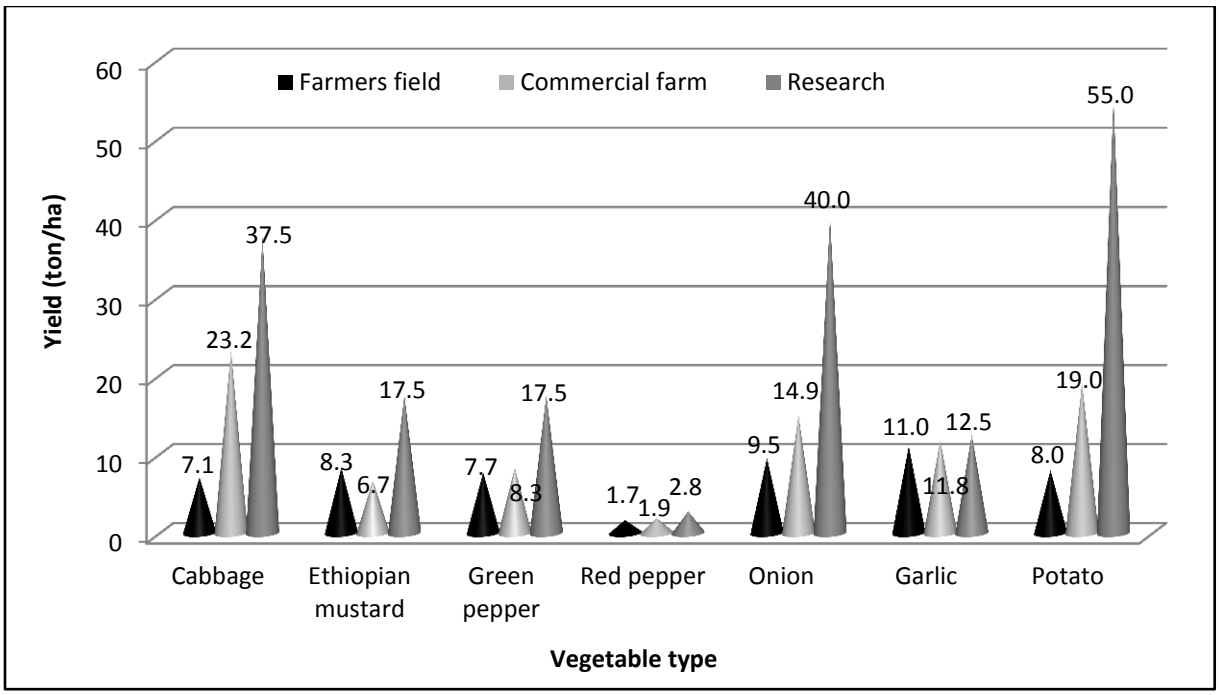
Table 6. Productivity of vegetables under irrigated and rain-fed production systems (tons/ha)

Vegetable type	District average		Average of sample kebeles
	Rain-fed	Irrigated	
Tomato	14.3	12.5	19.2
Cabbage	13.5	13.8	21.6
Kale	20.9	19.8	21.8
Onion	10.4	13.3	17.4
Garlic	4.9	7.1	3.9
Hot pepper	1.8	11.3	11.6
Sweet pepper	7.8	–	
Beet root	11.0	13.8	15.0
Swiss-chard	19.0	16.5	
Lettuce	19.0	15.0	
Carrot	9.8	13.2	14.7
Ethiopian mustard	8.3*	–	
Pumpkin	0.6	–	
Sweet potato	7.1	12.2	17.0
Potato	12.3	13.4	–
Leek	6.7	6.3	–

Source: computed from district data; *CSA (2011)

Generally, the average productivity of all crops was by far lower than the yield potential of the crops recorded by research centers in research stations and on-farm demonstration plots using improved management practice (Figure 3). The low productivity on farmers field and on-farm demonstrations plot can be attributed to low use of inputs such as fertilizer and crop protection chemicals as well, inadequate cultural management practices such as weed control and knowledge gap in production and management techniques. For instance, tomato yields can be as high as 40 tons/ha in research stations, 25 tons/ha at on-farm demonstration plots, while the national average yield is about 9 tons/ha (TEKLEWOLD and MEKONNEN, 2012). For vegetable crops such as tomato, onion, carrot, beetroot, Swiss chard and lettuce, the lower productivity cannot be ascribed to the use of low yielding cultivars per say since in all cases seeds of improved varieties are used by the farmers. However, these cultivated varieties are highly susceptible to diseases and insect pest infestation, moisture stress, lack/suboptimal uses of inputs such as fertilizers and chemicals as reported by farmers.

Figure 3. Productivity of some vegetables under farmers, commercial and research settings



Sources: adapted from DESALEGN et al. (2012) and GEBRE (2013)

3.3 Reasons for smallholders engagement in vegetable production and marketing

Smallholders' decision to produce and utilize vegetables is often triggered by consumption/nutritional, social and medicinal values. Evidence from several studies show that, due to their short production cycles and relatively high per unit farm gate values compared to most cereals and other starchy staple crops, vegetable production is more profitable, increases employment and income-generating opportunities and brings about increasing commercialization of the rural sector (see for example, WEINBERGER and LUMPKIN, 2007). In Ethiopia, vegetables and perennial crops such as coffee and khat provide cash to the household in the form of farm operational capital, household savings and own consumption. The majority of farmers thus sell vegetables to generate income to purchase agricultural inputs such as seeds, fertilizers and household assets such as livestock, irrigation water pump, and development of shallow wells for irrigation water supply among others. In the study sites, vegetables such as tomato, cabbage, onion, garlic, hot pepper, beetroots, Swiss chard, lettuce, and potato are mainly produced for market (Table 7).

Table 7. Proportion of experts and their indication of the purpose of vegetable production in all sites (%)

Vegetable type	Mainly for household consumption	Mainly for sale	For both consumption and sales equally
Tomato	–	88	12
Cabbage	–	79	21
Kale	46	23	31
Onion	8	79	13
Garlic	9	70	21
Hot pepper	29	52	19
Sweet pepper	25	42	33
Beet roots	–	87	13
Swiss chard	13	79	7
Lettuce	12	71	17
Carrot	–	83	17
Ethiopian mustard	46	48	6
Pumpkin	53	19	28
Sweet potato	28	39	33
Potato	6	67	28

Source: based on key informant interviews conducted by authors at study sites (2013)

As shown in Table 8, more than 65% of all major vegetables produced during the 2012 production year were sold on the market. The responses from interviewees were consistent and conclusive. This implies that vegetables provide substantial cash income generating opportunity for the farming community to access food (i.e., by selling marketed surplus and buying other food from the market) for enhanced livelyhoods.

Not surprisingly, most households producing vegetables for the market also consume a portion at home. However, only vegetables preferred as part of the regular diet are produced mainly for consumption by the household. As shown in (Table 7), kale, pumpkin and Ethiopian mustard are largely produced for consumption. Sweet potato (tuber is mostly consumed as a side dish) is considered as food security crop during periods of drought due to its drought-tolerance characteristics. In the study sites, sweet potato is considered predominantly as a key crop for resource poor farmers. Although, most vegetables are also grown by resource poor farmers, the scale of production is low and the purpose is largely for home consumption. The major reason for this observation is the lack of adequate capital to access inputs such as vegetable seeds, land,

irrigation facilities, as well as agro-chemicals; the prices of which are unaffordable to these farmers. Analysis of the survey data indicated that the rich and medium wealthy household groups[2] produce a variety of vegetables largely for sale while a portion is also consumed at home. Vegetables are consumed more by the relatively higher income group and better educated consumers, mostly in urban cities than resource poor and uneducated farmers. Except for garlic and potato which are produced only by rich and medium class farmers due to the high cost of planting materials, all other vegetables were produced by all income classes.

Table 8. Proportion of vegetables sold in four districts (%)

Vegetable	Guder	Yem	Meskan	Anlemo	Overall average
Tomato	92.5	85.0	86.3	62.5	83.5
Beet root	95.0	85.0	92.0	75.0	87.3
Swiss chard	95.0	87.5	90.0	90.0	90.0
Lettuce	95.0	87.5		90.0	90.0
Carrot	95.0	88.8	92.7	75.0	88.5
Eth. mustard	62.5	50.0	88.3	55.0	65.7
Pumpkin	62.5	70.0	77.5	60.0	70.5
Sweet potato	60.0	65.7	76.7	75.0	68.6
Cabbage	92.5	78.8	88.8	67.5	82.5
Irish potato	75.0	55.0	81.3	50.0	66.3
Kale		60.0	75.0	65.0	67.8
Onion	92.5	78.8	91.3	70.0	83.8
Garlic	100.0	73.8	94.0	90.0	84.8
Hot pepper	87.5	60.0	87.0	70.0	75.3
Sweet pepper		70.0			70.0
Green beans			98.0		98.0

Source: based on focus group discussions conducted by authors (2013)

During the survey, it was observed that horticulture experts were mostly aware of the nutritional importance and quantities of various vitamins and other nutrients of the top five vegetables produced in their area. However, specific nutritional values of vegetables are not well known to farmers. Moreover, most of the development agents who are supposed to promote the adoption of improved vegetables production practices do not know the specific nutritional value of the crops. Only 33% of the respondent development agents indicated that crops such as tomato, cabbage, and kale serve as important

[2] Wealth group was determined in relative terms as perceived by the respondents.

sources of vitamins, 8% indicated that onion, hot pepper and carrot are rich sources of vitamins. On the other hand, 8-25% of the development agents respondents do not have a fair knowledge of the nutritional values of most vegetables. About 33% of the development agents indicated that potato is an important source of carbohydrate. This reveals a knowledge gap to persuade farmers to produce vegetables which is part of the extension packages outlined by the official agricultural extension program in the country.

In addition to their economic and nutritional importance, vegetables also possess social and medicinal values. Consequently, development agents and farmers (through FGD) were asked whether they were aware of the social value and medicinal values of vegetable crops commonly produced in their area. About 42-50% of development agents responded that vegetables such as tomato, cabbage, kale, onion and potato are usually offered as gifts to relatives or neighbors as a means of social support. This occurs mainly when the relatives or neighbors do not have own access to such vegetables. About 25% and 8.3% of the respondents stated that kale and cabbage play key roles in preventing constipation, respectively. Another 8.3% of the respondents also stated that onion, garlic and sweet pepper have medicinal value although they do not know exactly what it is. Carrot has medicinal value for 25% of the respondents while garlic is considered as medicine for preventing various diseases such as common cold.

Production Constraints

Despite the immense merits of vegetables to farmers, their production has been constrained by a myriad of biotic (i. e., diseases, insect pests and weeds) and abiotic factors (i.e., soil acidity and low soil fertility) as well as institutional (e.g. policy, market, and infrastructure). The constraints could thus be categorized under 3 factors viz: (i) natural factors, (ii) institutional and policy factors, (iii) market factors.

The natural production constraints identified include the perishable nature of vegetables, pests and diseases infestation, and extreme moisture levels (i.e., high during rainy season, and shortage during the dry season). The results from the key informants and FGDs stress the critical importance of postharvest losses which occur due to the perishable nature of vegetables and lack of appropriate postharvest handling practices and processing technologies. The high incidence of insect pest and diseases infestation further accentuates high pre-harvest and postharvest losses. In adequate or erratic rainfall or lack of irrigation water was also found to result in low moisture stress, causing yield reduction. As indicated in Table 9, tomato was among the most significantly affected crops by diseases (97%), postharvest loss (82%) and low moisture stress (68%) as the pooled data from all respondent categories. Cabbage and onion

come after tomato in terms of susceptibility to low moisture stress (55%) and postharvest loss (44%). Late blight caused by *Phytophthora infestans* and bacterial wilt caused *Ralstonia solanacearum* were reported as the important diseases that affect potato and tomato in the study areas. There was no reported disease affecting Ethiopian mustard production in the study area, although aphids were reported to cause heavy damage. Only 8% of the experts interviewed mentioned carrot to have been suffering from diseases and pests. Powdery mildew was among the most important diseases of carrot. Garlic, beetroot, carrot and Ethiopian mustard were among the crops having no specific reported problems of postharvest losses, as far as transportation distance is not too long.

The major institutional constraints affecting vegetable production relates to the lack of access to improved and pest and disease resistant vegetable varieties, especially for potato, sweet potato, hot pepper and tomato and lack of a functional vegetable seed certification/regulatory system, ultimately resulting in the use of uncertified poor quality seeds by farmers. This partly as a result of the lack of private seed companies involvement in the vegetable seed supply and distribution channel. Almost all vegetable seeds are imported with their quality and sources hardly known. This has an impact on the overall production and lack of institutionally coordinated (e.g., as through cooperatives/union, MoA) seed supply system in some districts such as Guder and Ambo in the study areas. Other factors include the fragmented nature of vegetable farms creating inconvenience for coordinated market linkages and lack of policy initiatives to address the issue. Despite the fact that government planned to develop small scale irrigation, which is often used for vegetable production, there is inadequate irrigation water in some districts (Guder, Ambo, Yem), resulting in conflict among farmers associated with periodic rationing of irrigation water use.

Vegetables are also sold at local markets in villages and district capitals. Lack of a reliable market in all the zones appears to be another critical bottleneck of vegetable farming. Discussions particularly with producers and traders revealed that the existing market infrastructure and poor transport and warehouse facilities do not suit the perishable nature of vegetables as a result of which the quality of vegetables such as tomato and onion deteriorates. During the peak vegetable production season, farmers are forced to sell the products at extremely low prices particularly for tomato, and onion (because of lack of appropriate storage structure to avoid sprouting) thereby discouraging farmers from producing in the immediate subsequent season. Producers and local traders lack reliable market information and support systems. Brokers and wholesalers in the terminal market determine prices and even sometimes refuse buying harvested produce. Due to the perishable nature of vegetables, producers are forced to become price takers and accept low prices offered by brokers and wholesalers and even in some cases abandon their produce in market. The largest proportion of respond-

ents indicated that tomato suffers from lack of market access and/or poor prices received (82%). Similarly, cabbage (53%) and onion (50%) are also largely affected by marketing related problems (Table 9).

Table 9. Percentage of experts, DAs and FGD participants mentioning factors affecting vegetable crops production

Vegetable type	Abiotic factors				Biotic factors			
	Low moisture stress	Market* problem	Post-harvest loss	Frost	Disease	Insect	Weed	Seed impurity
Tomato	68	82	82	0	97	44	8	8
Cabbage	55	53	44	0	31	52	7	0
Kale	16	23	5	8	2	18	0	0
Onion	37	50	24	8	52	29	7	8
Garlic	5	13	0	0	13	8	2	0
Hot pepper	10	8	8	0	21	8	2	0
Sweet pepper	13	11	3	0	11	11	2	0
Beet roots	15	5	0	0	3	13	0	0
Carrot	10	5	0	0	8	0	0	0
Potato	27	29	16	0	37	6	0	0

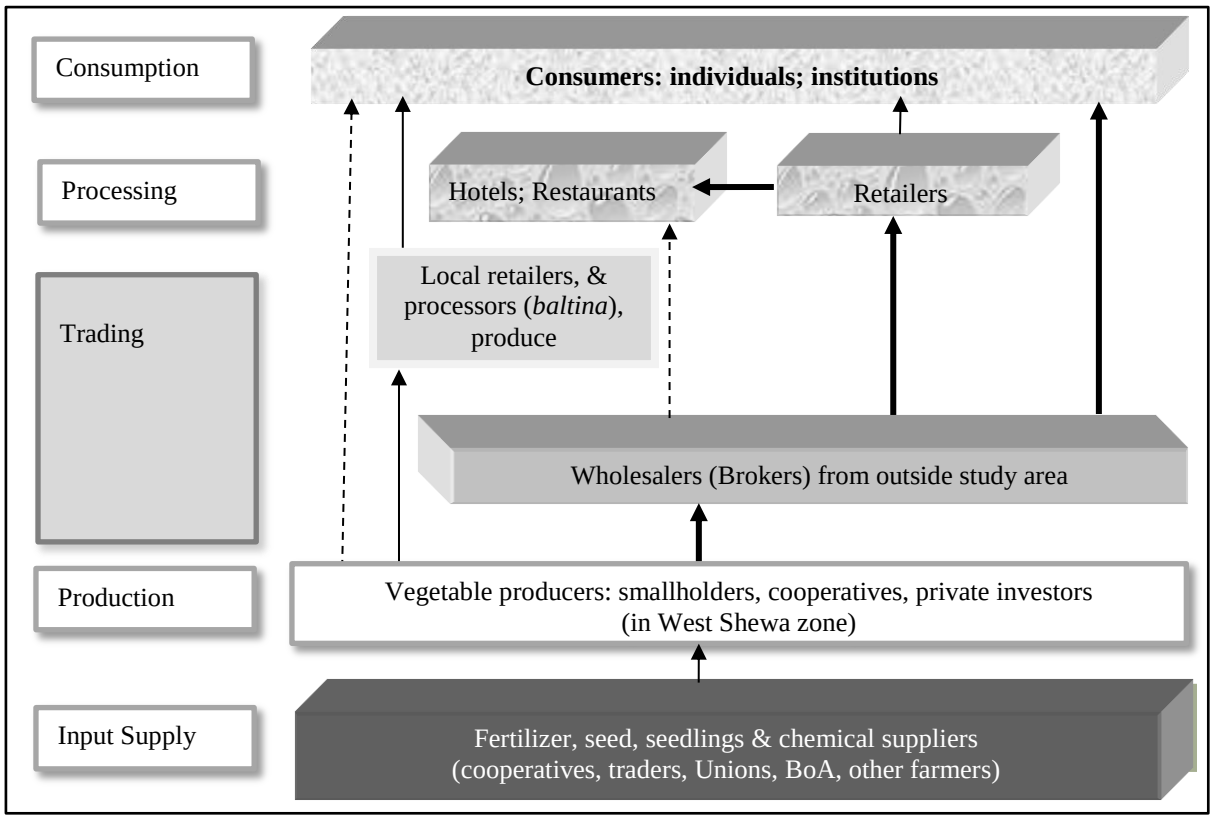
*Market problem includes low price, unavailability of market and market information.

Source: based on focus field survey conducted by authors (2013)

Vegetable value chains and marketing functions

The functions involved along the value chains of various vegetables in the districts are more or less similar. Differences appear mainly in the channels produce pass through in the trading functions and actors assuming different roles. Thus, mapping of value chain functions mainly shows the relationships and integration of the processes and activities performed along the value chain. Major value chain functions include: input supply, production, trading, processing and consumption. Figure 4 displays the functions or processes in vegetables value chain, the activities performed under each of the functions and the actors among the different value chains.

Figure 4. Mapping of vegetable value chain functions and actors in the humid tropics of Ethiopia



Source*:* authors' own conception (2013)

Regarding inputs, seeds, fertilizer, and pesticides are usually supplied to farmers by farmers' cooperatives/unions, traders and other individual farmers. Most farmers also recycle seeds of specific varieties by saving each season and do occasionally exchange with other farmers. Seeds of improved varieties are also supplied by private traders and cooperatives or unions. A limited number of private investors in the Rift Valley also produces seeds of some vegetables (onion and tomato) and sells to farmers, or NGOs which purchase seeds and distribute to farmers through their respective development programs. District level agriculture offices of Yem and Meskan districts engage in input supply activities. Production involves agronomic and farm management practices to transform inputs into outputs. Smallholder farmers are the main actors in this process. Farmers are also involved in postharvest handling practices and marketing of the produce. Very few private investors are engage in vegetable farming around urban areas as is the case of Ambo and Guder districts.

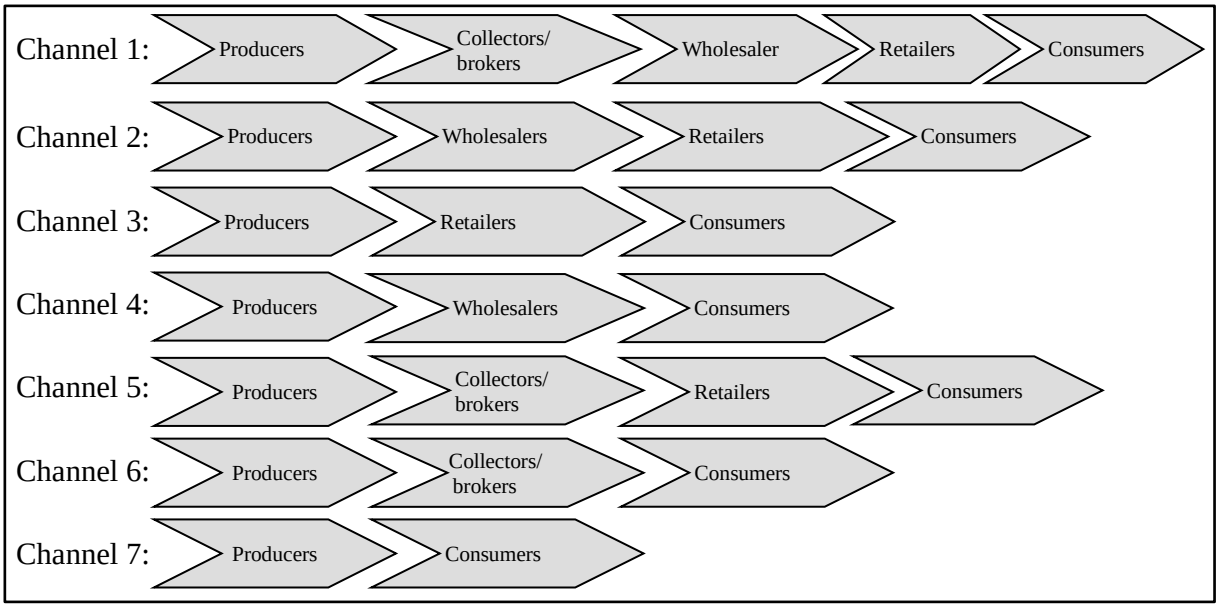
Marketing functions are mostly carried out by producers, retailers and whole sellers from outside the study areas. For commodities produced within the study areas, however, all marketing activities are handled either by retail shops mixing vegetables with fruits or farmers who sell the products in open markets. At Anlemo and Yem-Special districts there are no retailers in the value chain performing standard marketing functions. Wholesaler participation is only for limited commodities (onion, potato and garlic). In both Ambo and Butajira towns there are also retailers selling vegetables to urban consumers. Processing of vegetables, in the sense of preserving and value addition, is not practiced as such in the study areas. Processing is undertaken mainly by hotels or restaurants in which case fresh and cooked vegetables are sold to consumers. In major towns of the study areas, very few individuals process potato into chips and sell by the roadside.

The consumer base includes urban, per-urban and rural dwellers, who buy and consume a wide range of vegetables. Village market consumers and farmers themselves absorb a substantial volume of the produces. In terms of consumers groups, FGD participants in Anlemo district were of the opinion that vegetables are mainly produced for urban consumers with little for their communities.

Marketing Channels

Producers sell vegetables through different channels. The shortest channel is direct sales to consumers as shown in Figure 5 (Channel 4). Producers also sell to local collectors or wholesalers or retailers. At Yem and Anlemo districts, the marketing channels were found to be much shorter with produce sold mainly at village markets or district markets. Retailers are not typically involved in marketing related activities in these districts. In Meskan district, produce are sent to urban centres and sold in open markets although few retailers operate. In this case, producers sell the produce to consumers and retailers as well as to wholesalers based in markets outside the district. There are approximately 12 vegetable traders at Buta Jira, the capital of Meskan district. These traders transport the product to other markets including Addis Ababa at peak supply periods. At Ambo district, about four wholesalers take part in vegetable marketing serving as major providers to retail shops and hotels in the town.

Figure 5. Vegetable marketing channels in the study area



Source*:* authors' own conception (2013)

Marketing Constraints

The major marketing constraints include high postharvest losses, poor marketing and value chain development, and weak linkages and integration among value chain actors. Postharvest losses of vegetables are high primarily because of poor postharvest handling, poor storage infrastructure and transportation facilities as well as poor market information and support systems in rural areas. Smallholders in rural areas are often poorly linked to markets and do not adequately access functional market information. Often middlemen do make much higher marketing margins than the producers, limiting the motivation of farmers to expand vegetable production, not forgetting the associated high input costs such as fertilizers and agrochemicals. Vegetable value chains are also generally poorly developed. Although there are many public, private, NGOs and development partners working across the entire vegetable value chain, including seed systems, there are weak linkages and integration among the chain actors. As a result, there are no consistent and complementary synergistic efforts to develop the horticultural sector of Ethiopia (DCG, 2007).

4 Conclusions and Recommendations

Vegetables are an integral part of the farming system, which plays a crucial role in the economy of Ethiopia. Vegetable production is increasing as a result of increased area

allocation as well as increased yield per unit area as well as area put under production. Much of the increase in production comes from area expansion and increase in small-scale irrigation activities, enabling two or more production cycles per year. However, productivity at smallholders' level is very low compared to yields obtained at research centers. Production is constrained by diverse abiotic and biotic factors. Lack or limited access to improved seeds, diseases and insect pests, high postharvest losses and poor marketing system are the major challenges of the sub-sector with tomato suffering the most from these challenges. Vegetable marketing is also constrained by lack of market information systems, poor market linkages, low institutional support, lack of value chain development to ensure participation and benefit to the smallholders. This necessitates looking into the whole vegetable system development via a value chain upgrading/development approach.

Based on the findings of the study, the following recommendations are proffered:

i. Improve the technical knowledge and skill of farmers and development agents in vegetable production and crop protection measures by providing training in improved production and crop husbandry practices and use of quality inputs so has to provide effective extension service to increase vegetable yield.

ii. Expand irrigation facilities and improve cost efficiency of irrigation water use by improving the irrigation system for example by shifting from flood and furrow irrigation to drip and sprinkler irrigation methods.

iii. Increase public and private sector investment in irrigated vegetable production to increase the supply of vegetables since analysis of data from commercial farms revealed higher yield of vegetables compared to smallholder farms due to increased use improved inputs, particularly irrigation.

iv. Strength research-farmer-extension linkages to develop improved varieties adapted to diverse biotic and a biotic stresses, and improved management practices so as to overcome the current production pitfalls to address the wider observed yield gaps.

v. Develop improved and affordable postharvest handling and storage structures to prolong shelf life and minimize postharvest losses.

vi. Build the capacity of farmer’s cooperatives/unions so as to provide cooperatives with much better opportunities for integrating smallholders into vegetable value chains so that the profit margins of the farmers could be improve.

vii. Engage government and policy makers in frequent dialogues to increase their awareness so as to enhance widespread implementation of vegetable seed certification policy/regulations to support vegetable value chain development so that farmers get sustainable incentive to increase production.

References

ADISH, A. (2012): Micronutrient deficiencies in Ethiopia: Present situation and way forward. Downloadable at: http://www.epseth.org/a/files/Micronutrient%20Deficiencies%20in%20Ethiopia.pdf, accessed 11 Nov 2014.

AGONAFIR, Y. (1991): Economics of horticultural production in Ethiopia. ISHS Acta Horticulturae 270: I International Symposium on Horticultural Economics in Developing Countries, Acta Hort. (ISHS) 270: 15-20. URL: http://www.actahort.org/books/270/270_1.htm (referred to 31 March 2015).

AKLILU, S. (2000): Research achievement on variety development and seed production of vegetable crops in Ethiopia. In: Chadha, M.L., E.C. Altoveros, R. Nono-Womdim and H. Mndiga (eds.): AVRDC Africa Regional Program 2000. Varietal evaluation and seed production of vegetable crops. Proceedings of workshop held at AVRDC Africa Regional Program, Arusha, Tanzania from 29 September to 05 October 1997. AVRDC ARP Publication No. 2000-2. Asian Vegetable Research and Development Center – Africa Regional Program, Arusha, Tanzania: 6-11.

ALEMAYEHU, N., D. HOEKSTRA, K. BERHE and M. JALETA (2010): Irrigated vegetable promotion and expansion: The case of Ada'a District, Oromia Region, Ethiopia. Improving the productivity and market success of Ethiopian Farmers (IPMS) Case Study Report, International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia. Downloadable at: http://cgspace.cgiar.org/handle/10568/1422, accessed on February 11, 2014.

BAREDO, Y. (2013): Gamo Gofazone diagnosis and planning document. Livestock and irrigation value chains for Ethiopian smallholders (LIVES) project research report, Addis Ababa, Ethiopia. Downloadable at: http://www.lives-ethiopia.wikispaces.com/file/view/Gamo%20Gofa%20, accessed March 10, 2014.

CSA (Central Statistical Agency) (2011; 2013): Large and medium scale commercial farms sample survey 2010/11. Statistical Abstract Report, Volume VIII and Area and Production of Crops and Farm Management Practices, Statistical Bulletin 505, Addis Ababa, Ethiopia.

– (2012): http://www.csa.gov.et (referred to Crop Production statistics of respective years) (referred to 19/4/2014).

DCG (Drylands Coordination Group) (2007): Constraints and opportunities of horticulture production and marketing in eastern Ethiopia. DCG Report # 46 (February), Oslo, Norway. Downloadable at: http://www.everythingharar.com/publication/Report%2046.pdf, accessed March 10, 2014.

DEMISSIE, T., A. ALI and D. ZERFU (2009): Availability and consumption of fruits and vegetables in nine regions of Ethiopia with special emphasis to vitamin A deficiency. In: Ethiopian Journal of Health Development 23 (3): 216-222.

DESALEGN, L., S. AKLILU, G. TABOR, S. KETEMA and K. ABEBE (2012): Progress, success, and challenges in Ethiopian vegetable seed system. In: Wold, A.T., A. Fikre, D. Alemu, L. Desalegn and A. Kirub (eds.): The Defining Moments in Ethiopian Seed System. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia: 461-476.

EHDA (Ethiopian Horticulture Development Agency) (2011, 2012): Exporting Fruit and Vegetables from Ethiopia: Assessment of development potentials and investment options

in the export-oriented fruit and vegetable sector. Addis Ababa, Ethiopia. Downloadable at: http://www.diversityabroad.com/administrator/userpics/userimage9194.pdf, accessed November 19, 2013: 51.

ETHIOPIAN INVESTMENT AGENCY (2008): Investment opportunity profile for tomato processing in Ethiopia. Ethiopian Privatization Agency, Addis Ababa, Ethiopia. Downloadable at http://www.eap.gov.et/?q=node/817, accessed March 10, 2014.

– (2012): Investment opportunity profile for production of fruits and vegetables in Ethiopia. Ethiopian Privatization Agency, Addis Ababa, Ethiopia. Downloadable at http://www.ehpea.org.et/vege%201.htm, accessed March 10, 2014.

ETHIOPIAN REVENUE AND CUSTOMS AUTHORITY (2013): Export of 2013. Addis Ababa. Downloadable at http://www.erca.go.et, accessed on April 19, 2014.

FAO (Food and Agriculture Organization) (1984): Agroclimatic resource inventory for land use planning in Ethiopia. Technical Report 2. AG: DP/ETH/78/003. Rome, Italy.

HAJI, J. (2007): Production efficiency of smallholders' vegetable-dominated mixed farming System in Eastern Ethiopia: A non-parametric approach. In: Journal of African Economies 16 (1): 1-27.

TABOR, G. and M. YESUF (2012): Mapping the current knowledge of carrot cultivation in Ethiopia. Research Report Submitted to Carrot Aid (August), Denmark. Downloadable at http://www.carrotaid.org/reports/taboryesuf2012.pdf, accessed on April 19, 2014.

TEKLEWOLD, A. and D. MEKONNEN (2012): The Role and Performance of the Formal Seed System. In: Teklewold, A., A. Fikre, D. Alemu, L. Desalegn and A. Kiruti (eds.): The Defining Moments in Ethiopia Seed System. Ethiopian Institute for Agricultural Research, Addis Ababa, Ethiopia.

WEINBERGER, K., and T.A. LUMPKIN (2007): Diversification into horticulture and poverty reduction: A research agenda. In: World Development 35 (8): 1464-1480.

ZELLEKE, A. and S. GEBREMARIAM (1991): Role of research for horticultural development in Ethiopia. ISHS Acta Horticulturae 270, International Symposium on Horticultural Economics in Developing Countries, Acta Hort. (ISHS) 270: 189-196. URL: http://www.actahort.org/books/270/270_22.htm (referred to 31 March 2015).

Acknowledgements

The financial support of the Integrated Agricultural Systems of the Humid tropics program, a CGIAR Research Program for this research study is gratefully acknowledged.

Contact author:
Victor Afari-Sefa
AVRDC - The World Vegetable Center (AVRDC), Eastern and Southern Africa, P.O. Box 10 Duluti, Arusha, Tanzania
e-mail: victor.afari-sefa@worldveg.org