Research article

Profitability and market performance of smallholder vegetable production: evidence from Ethiopia

Ibrahim Aliyi*, Abduselam Faris, Assefa Ayele, Alemayehu Oljirra, Mulubrihan Bayessa

Department of Agricultural Economics and Agribusiness Management, College of Agriculture and Veterinary Medicine, Jimma University, P.O. Box 307, Jimma, Ethiopia

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ABSTRACT

Regardless of the fact that the vegetable crop is crucial for Ethiopia's economy, public research on vegetable crops was negligible, and limited attention has been given to the sector. The main objective of the study was to analyze profitability of vegetable production, market performance and identify major constraints of smallholder vegetables production, specifically potato, tomato and cabbage. A multi-stage sampling procedure was employed to select 420 sample households randomly from nine kebeles, and 139 traders were selected purposively. Both qualitative and quantitative data were collected from primary and secondary sources by using structured questionnaires. Descriptive statistics, gross profit formula and structure-conduct-performance model was applied to analyze the data. The result of profitability analysis showed that potato, tomato and cabbage production in the study area was profitable. The result of structure analysis indicated that the market structure for potato, tomato and cabbage was characterized by weak oligopolistic market. The analysis of market conduct showed that the price of vegetables was determined by traders. Performance analysis demonstrated that the total gross marketing margin and profit margin was highest when producers sold vegetables to consumers and the lowest when they sold vegetables to collectors across the channel. Shortage of inputs, pests and diseases, lack of improved storage, post-harvest loss, brokers' interventions, low price of the product, poor transportation facility and information flow were the major constraints. Therefore, policy initiatives aiming at increasing farmers' access to quality vegetables inputs, strengthen vegetable extension services, improving infrastructure, disseminating reliable market information, reducing unfair profit distribution and increasing bargaining power of farmers to accelerate rural economic growth and poverty reduction. In addition, research institutes and universities should significantly contribute in releasing high yielding and disease resistant varieties to improve production and productivity of vegetables sector.

1. Introduction

Agriculture is a key sector for Ethiopia's economy. The general economic growth of the country is highly dependent on the success of the agricultural sector. The entire sector offers employment to 72.7% of the population and contributes 43% to the GDP. The sector remains largely dominated by rain-fed subsistence farming by smallholders who cultivate an average landholding of less than one hectare (Amsalu, 2014). Despite these challenges, Ethiopia has favorable economic opportunities and prospects. The country has abundant natural resources, a low cost and trainable labor force, an emerging middle class, and a developmental state with an ambitious vision, commitment, and a strong sense of policy ownership (Getaneh and Sailaja, 2017).

Ethiopia exported 0.22 million tons of vegetables and generated USD 438 million in 2013 (Ethiopian Revenue and Customs Authority, 2013). Vegetable cultivation is a significant economic activity and play a central role in meeting food and nutrition security in Ethiopia, diversifying and increasing vegetable production can help to overcome malnutrition and poverty by augmenting household consumption and also create new income and employment opportunities in the production, trading, and processing sub-sectors (Ganry et al., 2010; Parrot et al., 2010; Virchow, 2015).

In spite of the fact that vegetable production is crucial for Ethiopia's economic growth and poverty reduction, limited attention has been given to the sector. Public research on vegetable crops was negligible and major public policies and attention of extension agents were mainly focused on staple crop production so far MoFED (2010). The majority of

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Ethiopian smallholders consider vegetable cultivation as supplementary to the production of main crops and the cultivation is fragmented and mostly dominated by household labor. This low priority for vegetable crop cultivation was due to the traditional food consumption habits that are mostly dominated by grain crops in many parts of the country which leads to weak domestic market demand for vegetable production (Bezabih and Hadera, 2007).

Ethiopia has a comparative advantage in a number of horticultural commodities due to its favorable climate, proximity to European and Middle Eastern markets and cheap labor (EHDA, 2012). The area under vegetables was estimated to be 0.44 million hectares with a total production of 53 million tons which shares about 1.69 percent of the area under all crops at national level (Cochrane and Bekele, 2018).

Most poverty reduction strategies in developing countries are predicated on improving agricultural production and promoting market access and integration of smallholder producers in formal market exchange. Improved market access proves necessary for maintaining production incentives, permitting household specialization and enabling movement to high-value products and to value-added activities. However, small-scale producers in developing countries, struggle to gain market access because they lack knowledge of market requirements or the skills to meet them, inadequate information flow and other obstacles prevent them from entering into new markets, or reduce the benefits they obtained from entry, reducing poverty among small-scale producers, are often designed to overcome some of these obstacles (Steven et al., 2012).

Ethiopia cannot be an exception from these challenges, the vegetable markets are characterized by inadequate transport network, poor market information system, and underdeveloped industrial sectors (Haji, 2008). The production-market linkage is very weak, smallholder farmers are not selling their produce in an organized manner, they are not getting the right share of consumer price. As a result, farmer’s opportunity to diversify their livelihoods from vegetable production is very much limited (Mussema et al., 2013). Legesse et al. (2014) reveals that wholesalers are making the highest net margin as they relatively charge a higher price using their market power. The net margin for the smallholder farmers is highest only when vegetables are sold to individual consumers through unions via consumer cooperatives. Teggen (2013) found out that the vegetable market chain is governed by wholesalers and exporters who have capital advantage over the other chain actors. Hence, farmers are forced to obtain a lower share of profit margin. Bezabih (2008) also identified that lack of markets to absorb the production, large number of middlemen in the marketing system, lack of coordination among producers, poor product handling and packaging, imperfect pricing system and lack of transparency in market information as major marketing challenges.

Southwest Ethiopia, particularly districts of Gomma, Dedo, and Seka Chokersa has a worthy potential in the production of vegetables. The main type of vegetables produced in the area is onion, potato, cabbage, green peppers, sweet potato, carrot, Garlic, etc (Kebebew et al., 2011). Among the vegetables produced in the area, the emphasis of this study lies on potato, tomato, and cabbage. The choice of the crops intentionally based on their major production and marketability. They are the most important vegetable crops in the area because they contribute a significant benefit to the livelihood of smallholder farmers.

2. Methodology

2.1. Description of the study areas

This study was conducted in three districts of the Jimma zone, including Gomma, Dedo, and Seka Chokersa (Figure 1). Jimma zone comprises 20 administrative districts with 2.5 million populations of which 94% are rural inhabitants (Population Census Commission, 2008). Jimma zone covers a total area of 15,569 km² and receives mean annual rainfall ranging between 1,200- and 2,800-mm. Subsistence farming is the dominant form of livelihood in Jimma zone for about 85% of the population. The area has suitable agro-ecological potential with the lowest drought risk rating in the country (Millas and Aynou, 2004). Cereals (maize, teff (eragrostis tef), sorghum, and barley), pulses (beans and peas), cash crops (coffee and chat (Catha edulis), fruits and vegetable crops (banana, mango, orange, avocado, potato, tomato, cabbage, sweet potato, garlic, paper, and onion) are widely grown by smallholders as a means of enhancing family income and achieving food security (Kebebew et al., 2011). Among the vegetables produced in the area, the emphasis of this study lies on potato, tomato, and cabbage. The choice of the crops based on their major production and marketability.

2.2. Sampling procedure and sample size determination

2.2.1. Farmers sampling

In order to realize the objectives of this study, from Jimma zone, districts of Gomma, Dedo, and Seka Chokersa were selected purposively based on the vegetable production potential. In the second step, three kebeles from each district and a total of nine kebeles were selected randomly from the three districts. Finally, 420 sampled households were selected using a random sampling method assisted by probability proportional to size (Table 1). The simplified formula provided by (Yamane, 1967) was used to determine the sample size. Accordingly, the required sample size at a 95% confidence level with a degree of variability of 5% and the level of precision equal to 5% are used to obtain a sample size required.

\[
n_s = \frac{N}{1 + N(e^2)} = \frac{9985}{1 + 9985(0.05)^2} = 385
\]

where \(n_s\) is the sample size, \(N\) is total number of vegetable producer three districts of Jimma zone, \(e\) is the desired level of precision (\(e = 5\%\)) Besides this, the sample size was increased by 10% to compensate for nonresponse or for persons that the researcher is unable to contact. In this way the sample size was increased to 420 (Table 1).

2.2.2. Sample of traders

The sample size of traders included in the study was determined based on information obtained from the district trade and market development office. Accordingly, from the total of 349 traders, 139 traders including collectors, retailers, and wholesalers were selected purposively based on the value of the vegetable production they purchased and sold (Table 2).

2.2.3. Data types, sources, and methods of data collection

In this study, both quantitative and qualitative data types were collected from both primary and secondary sources. Primary data was
collected from farmers and traders through an interview schedule containing close-ended and open-ended questions. Informal surveys such as key informant interviews and focus group discussions were held by using the checklist. Secondary data was gathered from the Central Statistical Agency (CSA), through reviewing journals and examination of reports as well as records of published and unpublished documents.

2.2.4. Method of data analysis
In this study different descriptive methods, gross profit formula and margin analysis were employed to analyze the data collected. Descriptive statistics such as mean and percentage were used in the process of analyzing socio-economic, demographic and institutional characteristics of households.

2.2.5. Analysis of profitability
Gross Margin (GM) by definition is simply the difference between the total revenue (TR) and the total variable cost (TVC) as expressed by Segun-Olasanmi and Bamire (2010); Modu et al. (2010); Girei et al. (2013) and presented by the equation below;

\[ GM = TR - TVC; \lambda = GM - TFC \]  

where,

| Name of the district | Name of the Kebeles | Total number of vegetable producers | Proportion Sample Size |
|----------------------|---------------------|-----------------------------------|-----------------------|
| Gomma                | Ganji dalectho      | 1169                              | 0.12                  | 49                    |
| Chami chego          | 1044                |                                    | 0.1                   | 44                    |
| Jimnate deru         | 947                 |                                    | 0.09                  | 40                    |
| Dedo                 | Waro Kolobo         | 1351                              | 0.14                  | 57                    |
| Offole               | 1246                |                                    | 0.12                  | 52                    |
| Afaly Korti          | 1049                |                                    | 0.11                  | 44                    |
| Seka Chekora         | Dabbo Yaya          | 1175                              | 0.12                  | 49                    |
| Dabbo Gibe           | 1051                |                                    | 0.11                  | 44                    |
| Ushane qacce         | 953                 |                                    | 0.1                   | 40                    |
| Grand total          | 9985                | 1                                  | 420                   |

Figure 1. Map of the study area.
### Table 2. Sample of actors other than farmers.

| Name of the district | Actors                  | Number of actors | Number of sample |
|----------------------|-------------------------|------------------|------------------|
| Gomma                | Wholesaler              | 6                | 4                |
|                      | Collector               | 44               | 14               |
|                      | Retailer                | 56               | 19               |
| Dedo                 | Wholesaler              | 9                | 7                |
|                      | Collector               | 47               | 18               |
|                      | Retailer                | 68               | 28               |
| Seka Chokorsa        | Wholesaler              | 8                | 6                |
|                      | Collector               | 46               | 19               |
|                      | Retailer                | 65               | 24               |
| Grand total          |                         | 349              | 139              |

GM = Gross Margin, \( \Omega \) = profit, TR = Total Revenue, VC = Total Variable Cost, TFC = Total Fixed Cost.

The production efficiency (PE) per vegetable production was calculated as:

\[
PE = \frac{ATR}{ATC}
\]

where,

ATR = Average Total Revenue, ATC = Average Total Cost

#### 2.2.6. Structure, conduct and performance (S-C-P) model

The model was employed to examine the fundamental relationships between market structure, conduct and performance, and is usually referred to as the Structure, Conduct, and Performance (S-C-P) model. Amha (1994); Musema (2007) and Tadesse (2011) used this model to evaluate food grain, pepper and fruit market, respectively.

#### 2.2.7. Market concentration

The concentration ratio is a way of measuring the concentration of market share held by particular suppliers in a market. "It is the percentage of total market sales accounted for by a given number of leading firms". Thus a four-firm concentration ratio is the total market share of the four firms with the largest market shares. Kohls and Uhl (2002) suggest that, as a rule of thumb, a four enterprise concentration ratios of 50 percent or more is indicative of strongly oligopolistic industry, 33–50 percent a weak oligopoly, and less than that, an un-concentrated industry. The usual measures of market concentration as:

\[
C = \frac{\sum_{i=1}^{r} S_i}{\sum V_i}
\]

where \( C \) = concentration ratio, \( S_i \) = Percentage share of \( i^{th} \) firm, \( r \) = number of largest firms for which the ratio is going to be calculated.

\[
MS_i = \frac{V_i}{\sum V_i}
\]

where, \( V_i = Amount \ of \ product \ handled \ by \ the \ buyer; MS_i = Market \ share \ of \ buyer \ I; \sum V_i = Total \ amount \ of \ product \ handled \ by \ the \ r \ firms \)

**Market conduct** refers to the behavior of firms or the strategies used by the firms, for example, in their pricing, buying, selling, etc. The behavior of firms in setting their prices plays a vital role in the S-C-P paradigm (Scott, 1995).

#### 2.2.8. Market performance

Market performance can be evaluated by analysis of costs and margins of marketing agents in different channels. A commonly used measure of performance is the marketing margin or price spread (Bashargo and Srinivasa, 2002). Marketing margin analysis deals with comparison of price at different levels of marketing chain over the same period of time. It measures the share of the final selling price that is captured by a particular agent in the marketing chain and always related to the final price or the price paid by the end consumer, expressed in percentage (Mendoza, 1995). Hence, marketing margins are important indices in the evaluation of market performance. Marketing margin refers to the difference between the price paid to the first seller (farm-gate price) and the price paid by the final buyer (retail price) (Abankwah et al., 2010). A systematically recording price at different levels of marketing chain during a two to three week period was sufficient to calculate quite accurately the relevant marketing margins (Pomeroy and Trinidad 1995). Thus, selling price by actor was utilized to estimate marketing margins. Marketing margins for the various vegetable traders were estimated using the following formulas.

\[
TGMM = \frac{\text{Retailing(Consumer)Price} - \text{Producer Selling price}}{\text{Retailing(Consumer)price}} \times 100
\]

\[
GMMC = \frac{\text{Collector Selling Price} - \text{Purchasing price}}{\text{Retailing(Consumer)price}} \times 100
\]

\[
GMMW = \frac{\text{Wholesalers Selling Price} - \text{Purchasing price}}{\text{Retailing(Consumer)price}} \times 100
\]

\[
GMMR = \frac{\text{Retailing Price} - \text{Purchasing Price}}{\text{Retailing(Consumer)price}} \times 100
\]

\[
GMM_F = 100\% - TGMM
\]

where:

TGMM is the total gross marketing margin; 
GMMC is the percentage of total gross marketing margin received by collectors; 
GMMW is the percentage of total gross marketing margin received by wholesalers; 
GMMR is the percentage of total gross marketing margin received by retailers; 
GMM_F is the producer gross marketing margin. It is the proportion of the price paid by the consumer that belongs to the producers.

### 3. Results and discussion

This section presents the major findings of the study. A detailed description of sample households’ demographic and socioeconomic characteristics is presented. Further, the result of profitability and market performance of the potato, tomato and cabbage output market are presented.

#### 3.1. Demographic and socioeconomic characteristics of the farmers

Analysis of demographic and socio-economic characteristics of the sample unit is quite important to infer their close relationship with the vegetable marketing pattern of sample households. As indicated in Table 3, the mean age of sample households in the study area is 39 years with a standard deviation of 10 years. The mean family members of sample households is 7 in head count.

The mean distance to the nearest market is 0.64 walking hour from vegetable production point to the nearest market. A long-distance market discourages the intensive participation of farmers as it needs a lot of time and effort to deliver to the market. The mean production experience of farmers for potato, tomato, and cabbage were 13, 9 and 10 respectively.

The mean income obtained by sample households from non-farm income was 3451 birr ($93) \(^1\) and the mean average use of fertilizer per hectare for potato, tomato and cabbage were 24.88 kg, 11.35 kg, and 9.8 kg respectively. This implies that the use of fertilizer for vegetable production point to the nearest market. A long-distance market

\(^1\) Ethiopian currency was 37 birr in terms of USD at the time of the research.
production in the study area is very low, those households who use enough fertilizers per hectare produce optimum amount of vegetables. Therefore, to improve the production and productivity of vegetable, it is crucial to use fertilizer efficiently.

As depicted in Table 3, from the total of 420 sample households about 91.7% and 8.3% were male-headed and female-headed households, respectively. Among the sample farm households, about 45.2% of them were members of farmers’ cooperatives. Accordingly, about 52.1%, 66.9%, 21.7%, 20.7%, and 38.8%, of sample households had access to market information, extension service, credit, motor pump ownership and has transportation facility, respectively.

3.2. Characteristics of sample traders

Sex, age, family size, trading experience, education status, access to credit, access to the storage facility, access to information, access to transportation facility and initial working capital were the socio-economic and demographic characteristics used to describe the traders (Table 4).

The age of sample traders ranged from 25 to 78 years. The average age of all sample traders was 38.9 years and its standard deviation was 8.7 years. The family size of sample traders ranged from 1 to 12 people. The average family size of the total sample respondents of traders was found to be 7.4 person and its standard deviation was 2.55 person. The educational status of sample traders, on average was 5.43 schooling years and its standard deviation was 3.67 years.

Experience plays an important role in improving trading activities and marketing efficiency. The trading experience of sample traders ranges from 2 to 35 years and the average trading experience of sample traders’ respondents were 14.04 years.

The study result indicated that 55.5% of the sample traders were males while 44.5% of them were females. This implies that both women’s and male’s participate in vegetable trading. Likewise about 46.7% of the sample vegetable traders had access to credit but the majority of them (53.3%) did not use credit as working capital. On average, about 56.7%, 55.5% and 21.6% of sample traders had access to transportation facilities, access to information, and storage facility in the vegetable trading, respectively.

3.3. Profitability analysis of potato, tomato and cabbage production in the study area

Table 5 shows the profitability of potato, tomato, and cabbage production per hectare. The selected vegetables can be produced twice a year. The mean productivity of potato, tomato, and cabbage for the production year was 8.7, 6.3, 9.3 tons respectively. The costs of production and revenues were calculated to estimate the profitability of vegetable production.

Labor cost was estimated based on wage of labor per man/day. Costs of land preparation include: Cost for plowing (birr/ha), crop management include: labor cost for weeding (birr/ha), and chemical spray (birr/ha), fertilizer cost, chemical costs, seed cost, fuel cost, compost preparation, and harvesting cost were reported by the sampled respondents. The overall average cost for production of potato, tomato, and cabbage were 23,699 birr ($641), 21,832 birr ($590), 17,048 ($461) per hectare respectively. The average price for potato, tomato, and cabbage at farm gate were 451 birr ($12), 521 birr ($14) and 288 Birr ($8) per 100kg, respectively.

Therefore, the total revenue of sample respondent from potato, tomato, and cabbage were 39,390 birr ($1065), 32,633 birr ($882) and 26,798 birr ($724) per hectare, respectively. The benefit-cost ratio of potato, tomato, and cabbage production were 1.7, 1.5, and 1.6 respectively. The analysis for selected vegetable crops shows that vegetable production are profitable in the area. The result is consistent with that of Addisu (2016) who concluded that both potato and onion production are profitable.

3.4. Distribution of benefit along potato, tomato, and cabbage marketing channels

3.4.1. Potato marketing channels

Seven potato marketing channels were identified together with their total carrying capacity in the study areas. The study results indicates that around 709 tons of potato were delivered to the market by sample respondents. Wholesalers, collectors, consumers and retailers were the principal agents that obtained potato from the producers. With calculated amount of 54.06%, 14.3%, 20.16% and 11.47% respectively. In addition, channel comparison was performed based on volume of commodity flow. Accordingly, channel VII is the leading one in terms of carrying large amount of potato to the end users around the study area which accounts about 147 tons, followed by channel I and II with volume of 135 and 126 ton respectively. The study depicted the following marketing channels:

Channel I: Producer——Consumer (135 ton)  
Channel II: Producer——Retailer——consumer (130 ton)  
Channel III: producer——collector——wholesaler——Retailer——Consumer (126 ton)

| Continuous variable         | Potato | Tomato | Cabbage |
|-----------------------------|--------|--------|--------|
| Age of household            | Mean   | SD     | Mean   | SD     | Mean   | SD     |
| Distance to Market (kms)    | 39.30  | 10.39  | 39.30  | 10.39  | 39.30  | 10.39  |
| Family Size (number)        | 7.28   | 2.06   | 7.28   | 2.06   | 7.28   | 2.06   |
| Education (years)           | 3.1    | 3.27   | 3.06   | 3.27   | 3.1    | 3.27   |
| Total Livestock Unit (TLU)  | 6.31   | 3.69   | 6.31   | 3.69   | 6.31   | 3.69   |
| Fertilizer used (Kg)        | 24.88  | 51.77  | 11.35  | 24.28  | 6.31   | 3.69   |
| Farm Land (ha)              | 0.254  | 0.84   | 0.136  | 0.32   | 0.136  | 0.32   |
| Farm Experience (year)      | 13.40  | 6.05   | 9.48   | 4.68   | 9.7    | 4.78   |
| Non-Farm Income (birr or $) | 3451   | 19242  | 3451   | 19242  | 3451   | 19242  |
| DUMMY VARIABLES             |        |        |        |        |        |        |
| SEX(Male)                   | 385    | 91.7   | 385    | 91.7   | 385    | 91.7   |
| Owing motor Pump            | 87     | 20.7   | 87     | 20.7   | 87     | 20.7   |
| Member of cooperative       | 190    | 45.2   | 190    | 45.2   | 190    | 45.2   |
| Market information          | 219    | 52.1   | 219    | 52.1   | 219    | 52.1   |
| Use of credit               | 91     | 21.7   | 91     | 21.7   | 91     | 21.7   |
| Access to extension contact | 163    | 66.9   | 163    | 66.9   | 163    | 66.9   |
| Owing transportation        | 385    | 38.8   | 385    | 38.8   | 385    | 38.8   |

Table 3. Characteristics of the farmers for continuous and dummy variables.
3.4.2. Profit margin and share of profit along potato marketing channels

**Cost:** The major categories of costs along the chain are production, purchasing and marketing cost. Packing marital, labor for packing, loading and unloading, transport cost, post-harvest loss and overhead costs were the major marketing costs for vegetable producers and traders. Costs and marketing margins were used to estimate distribution of benefit in the market chain.

**Selling price:** The selling price of vegetable varies with time, market outlet and products quality. Thus, in order to calculate margins and profit share of actors, the average price for that particular channel was considered as selling price.

**Profit margin:** The profit margin by a given actor is calculated by deducting total cost from selling price. The share of profit margin of actors was computed in a relative term as the ratio of actor’s profit margin and total profit margin by all actors for that particular channel.

All figures in Table 6, are for 100 kg of potato product and shows marketing cost incurred by producer, collectors, wholesalers and retailers, and the share of profit margin for each actors. Profit margin for potato producers was the highest in channels IV and V (144 birr or $3.9) and the lowest in channel III, VI and VII (20 birr or $ 0.54) due to involvement of local collectors in this channel that purchase products at lower price. Wholesaler profit margin is the highest in channel V (202 birr or $5.5) and in channel IV (192 birr or $ 5) and the lowest in channel III (73 birr or $2). Retailer profit margin is the highest in channel II (289 birr or $ 7.8) and in channel VI (241 birr or $ 6.5) and the lowest in channel III and VI (80 birr or $2.16). Collector profit margin is the highest in channels III and VI (212 birr or $ 5.7) and VII (158 birr or $4.3), in this channel collectors obtained the maximum profit margin because they purchase the potato relatively at lower price from producers while producers obtained the lowest profit margin in this channel. The results also shows that the maximum profit margin obtained by that of retailers, which accounts 289 birr ($7.8)/100kg and 241 birr ($6.5)/100kg in channel II and VII respectively, followed by collectors which accounts 212 birr ($5.7) in channel III and VI. But as we see from the channel distribution, collectors and retailers purchase and sell potatoes in smaller quantities than wholesalers, so that the overall profit is smaller than the wholesalers. The result is in line with that of Dawit Setegn H, 2016 who found that traders are more benefited when they are purchase directly from farmers and sold to consumers.

The finding is also consistent with Dastagiri (2010) who concluded the highest percentage of benefit goes to potato wholesalers. The study result further indicated that the intermediaries play a crucial role in securing their profit margins.

### Table 4. Demographic and socio-economic characteristics of sample traders.

| Continuous Variable       | Type of trader | All sample Mean | Collectors (mean) | Wholesalers (mean) | Retailers (Mean) |
|---------------------------|----------------|-----------------|-------------------|--------------------|-----------------|
| Age (year)                |                | 38.9            | 37.9              | 40.04              | 38.7            |
| Experience (year)         |                | 14.03           | 14.5              | 13.9               | 13.7            |
| Education (school year)   |                | 5.43            | 4.98              | 5.78               | 4.73            |
| Family size (number)      |                | 7.4             | 7.9               | 6.95               | 7.1             |
| Initial capital in (Birr) |                | 9760            | 4750              | 17052              | 7479            |
| Net capital now in (Birr) |                | 68280           | 44979             | 92,052.5           | 67809.5         |
| Dummy variable (yes)      |                | (%)             | (%)               | (%)                | (%)             |
| Sex (male)                |                | 55.5            | 48.55             | 65.2               | 51.6            |
| Access to storage facility|                | 21.6            | 18.9              | 24.5               | 21.45           |
| Access to credit          |                | 47.6            | 12.2              | 73.3               | 53.6            |
| Access to information     |                | 55.5            | 43.3              | 76.7               | 55.5            |
| Transportation facility   |                | 56.7            | 12.2              | 56.7               | 62.7            |

| Channel | Type of trader       |
|---------|----------------------|
| IV      | producer—Wholesaler—Retailer—Consumer (72 ton) |
| V       | Producer—Wholesaler—consumer (47 ton) |
| VI      | producer—Collector—wholesaler—consumer (52 ton) |

### Table 5. Average cost of production and profitability of vegetable production (ETB/ha).

| Cost item                        | Type of Vegetable | Potato | Tomato | Cabbage |
|----------------------------------|-------------------|--------|--------|--------|
| Variable cost                    |                   |        |        |        |
| Costs of Seed                    | 5028              | 3465   | 2250   |
| Chemical fertilizer              | 2250              | 2516.3 | 1250   |
| Manure cost                      | 1040              | 923    | 967    |
| Costs of land preparation        | 1914              | 1910.3 | 1763.3 |
| Labor for crop management        | 1356              | 1733.7 | 1610.93|
| Labor for harvesting             | 1148              | 1123.4 | 898.73 |
| Chemical cost                    | 2701              | 2760.5 | 1700.94|
| Fuel cost                        | 1650              | 1500   | 1120   |
| Total variable cost (TVC)        | 17087             | 15922.2| 11560.9|
| Fixed cost                       |                   |        |        |        |
| Land rent                        | 1500              | 1029   | 1029   |
| Opportunity cost of land         | 2700              | 2471   | 2471   |
| Land Tax                         | 85                | 85     | 85     |
| Rent of motor pump               | 1079              | 1115   | 700    |
| Rent of pair oven                | 1248              | 1200   | 1200   |
| Total Fixed cost (TFC)           | 6612              | 5900   | 5485   |
| Total cost of production/ha      | 23,699            | 21,832.2| 17047.9|
| Cost of production/100kg         | 271.46            | 348.37 | 182.92 |
| Yield (ton/ha)                   | 8.73              | 6.27   | 9.32   |
| Average selling price/100kg      | 451.2             | 520.71 | 287.53 |
| Total Revenue/ha                 | 39390             | 32633  | 26798  |
| Gross Margin (TR-TVC)            | 22303             | 16701  | 15237  |
| Profit (GM-TFC)/ha               | 15691             | 10801  | 9752   |
| Input-output Ratio               | 1:1.66            | 1:1.5  | 1:1.57 |

2 Ethiopian currency was 37 birr in terms of USD at the time of the research.
### Table 6. Profit margins and share of profit along Potato marketing channels.

| Channel   | Actors       | Input/purchasing cost | Marketing cost | Total cost | Selling price | Profit margin | Share of profit (%) |
|-----------|--------------|------------------------|----------------|------------|---------------|---------------|---------------------|
| Channel I | Producer     | 272                    | 145            | 417        | 567           | 150           | 100                 |
|           | Total        |                        |                |            |               |               |                     |
|           | Producer     | 272                    | 95             | 367        | 503           | 136           | 32                  |
| Channel II| Retailer     | 503                    | 115            | 618        | 907           | 289           | 68                  |
|           | Total        |                        |                |            |               |               |                     |
|           | Producer     | 272                    | 25             | 297        | 317           | 20            | 5                   |
|           | Collector    | 317                    | 115            | 432        | 644           | 212           | 51                  |
| Channel III| Wholesale  | 644                    | 55             | 699        | 802           | 103           | 25                  |
|           | Retailer     | 802                    | 45             | 847        | 927           | 80            | 19                  |
|           | Total        |                        |                |            |               |               |                     |
|           | Producer     | 272                    | 85             | 357        | 501           | 144           | 35                  |
|           | Wholesaler   | 501                    | 99             | 600        | 802           | 192           | 46                  |
| Channel IV| Retailer     | 802                    | 45             | 847        | 927           | 80            | 19                  |
|           | Total        |                        |                |            |               |               |                     |
|           | Producer     | 272                    | 85             | 357        | 501           | 144           | 42                  |
| Channel V | Wholesaler   | 501                    | 99             | 600        | 802           | 202           | 58                  |
|           | Total        |                        |                |            |               |               |                     |
|           | Producer     | 272                    | 25             | 297        | 317           | 20            | 7                   |
|           | Collector    | 317                    | 115            | 432        | 644           | 212           | 70                  |
| Channel VI| Wholesale   | 644                    | 75             | 719        | 792           | 73            | 24                  |
|           | Total        |                        |                |            |               |               |                     |
|           | Producer     | 272                    | 25             | 297        | 317           | 20            | 5                   |
|           | Collector    | 317                    | 120            | 437        | 594           | 157           | 38                  |
| Channel VII| Retailer   | 594                    | 105            | 699        | 940           | 241           | 58                  |
|           | Total        |                        |                |            |               |               |                     |
|           |              |                        |                |            |               |               |                     |

3.4.4. **Profit margin and share of profit along tomato marketing channels.**

All figures in Table 7, are computed per 100 kg of tomato and indicates categories of marketing cost related to the transaction by producers, collectors, wholesalers and retailers, and the share of actor's profit margin. Excluding channel I, profit margin for tomato producers is the highest in channels III and IV (136 birr or $3.7) and relatively they obtain better profit margin in all channels. Accordingly, wholesaler's profit margin is the highest in channel III (184 birr or $5) and the lowest in channel VI (82 birr or $2.3). Similarly retailer's profit margin is the highest in channel II (232 birr or $6.27) and the lowest in channel VI (82 birr or $2.3) and also relatively they received better profit margin in channel IV, V and VII. Likewise, wholesaler's profit margin is the highest in channel VI (148 birr or $4) and the lowest in channel IV (106 birr or $2.9).

3.4.5. **Cabbage marketing channels.**

About seven cabbage marketing channels were identified, likewise total amount of products handled by the channels was also estimated in the study areas. The average amount of cabbage supplied was 781.2 tons. The main trade agents that receives cabbages from producers were wholesalers, collectors, retailers, and consumers with an estimated percentage share of 60.5%, 18.45%, 14% and 7.05% respectively. Moreover, comparison among channels was performed based on volume that passes through channels. As result, channel II is giant in terms of quantity of products that passes, which accounts 244.7 tons, followed by channel III with amount of 176.2 tons. The study revealed, the following major channels of cabbages.

Channel I: Producer———Consumer (73.2 ton)
Channel II: Producer———Retailer———Consumer (244.7 ton)
Channel III: producer———collector———wholesaler———Retailer———Consumer (176.2 ton)
Channel IV: producer———wholesaler———Retailer———Consumer (51.6 ton)
Channel V: Producer———Wholesaler———consumer (93 birr or $2.5)
Channel VI: producer———Collector———wholesaler———consumer (98.8 ton)
Channel VII: producer———Collector———Retailer———Consumer (87 ton)

3.4.6. **Profit margin and share of profit along cabbage marketing channels.**

All figures in Table 8, were calculated per 100 kg of cabbage and describes transaction costs incurred by producers, collectors, wholesalers and retailers, and the share of profit margin for each of marketing actors. As indicated on Table 8, profit margin for cabbage producers is the highest in channels II (232 birr or $6.27) and the lowest in channel VI (82 birr or $2.3) and also relatively they received better profit margin in channel IV, V and VII. Likewise, wholesalers' profit margin is the highest in channel VI (148 birr or $4) and the lowest in channel IV (106 birr or $2.9).

Similarly, retailer profit margin is highest in channel VII (262 birr or $7) and the lowest in channel III and IV (93 birr or $2.5). Collector profit margin is the highest in channels VII (263 birr or $7) and lowest in channel II and VI (54 birr or $1.5). The results also shows that the maximum profit margin from traders was received by retailers, with
about 262 birr ($7)/100kg in channel VII, followed by wholesalers which accounts 148 birr ($4) /100kg in channel VI.

3.5. Structure-conduct and performance of potato, tomato and cabbage

3.5.1. Market structure

To determine the market structure of potato, tomato and cabbage degree of market concentration were employed. Mostly the four firm’s concentration ratio (CR4) are used for judging the market structure. The four firm’s concentration ratio (CR4) greater than 50%, 33% up to 50%, and less than 33% is considered as strong oligopoly, weak oligopoly and un concentrated market respectively (Kohls, 1955). The levels of market concentrations (CR4) for selected vegetables were computed by adding the four largest trader's market shares. Market shares were estimated based on the amount of product handled by each unit, as a percentage of total volume handled in a market (Table 9). Accordingly, the levels of market concentrations (CR4) for selected vegetables were computed by adding the four largest trader's market shares. Market shares were estimated based on the amount of product handled by each unit, as a percentage of total volume handled in a market (Table 9). The results of the study show the selected vegetables market in the study area displayed a weak oligopoly market structure, this indicated that the existence of a low concentration vegetable market in the study area. The result is in line with the finding of Yaregal (2018) who found that potato market was characterized by weak oligopolistic.

3.5.2. Market conduct

In this section conduct of the vegetable market is analyzed in terms of producer and trader's price-setting strategies.

3.5.3. Producer's price setting strategy

According to the survey result, about 54% of sample farmer said that market price was set by buyers and 38% of respondents said that price was set by negotiation. This indicates that majority of producers are price taker.

3.5.4. Purchasing and selling strategy of trader

Study finding shows that the majority (50.8 %) of the respondents cited the price is determined by market (demand & supply) similarly about 28%, 12.2% and 9% of respondents reported that the price was set by negotiating with suppliers, discussing with other traders and by themselves respectively (Table 10).

3.6. Analysis of market performance for potato, tomato and cabbage production

3.6.1. Marketing margins of potato at different channels

The study show that marketing margin among actors across channels of potato, tomato and cabbage (Table 11). Furthermore, the finding show that the highest and the lowest total gross marketing margin (TGMM) for potato production, were 66% and 37.5% in the channel III and channel V, respectively. Excluding the scenario of channel I producer's share (GMP) was the highest (62.5%) and the lowest in channel III (34%). The results also shows that the maximum gross marketing margin among traders was obtained by retailers, which accounts 44.4% of the consumer's price in channel II followed by collectors which was 41% in channel VI. Based on the finding we can conclude that, producers obtained higher percentage share of margin when they directly supplied their products to consumers.

3.6.2. Marketing margins of tomato at different channels

Tomatoes marketing margins for specific market participants was presented on Table 11. Accordingly, total gross marketing margin (TGMM) is highest (46%) in channel V and VII and lowest (34%)in channel III. Likewise, producer's share (GMMp) was highest (66%) in channel III and relatively lowest in channel V and VII. The variation in

| Channel | Actors | Input/purchasing cost | Marketing cost | Total cost | Selling price | Profit margin | Share of profit (%) |
|---------|--------|------------------------|----------------|------------|---------------|--------------|---------------------|
| Channel I | Producer | 348 | 80 | 428 | 604 | 176 | 100 |
| Total | Producer | 176 | 100 |
| Channel II | Retailer | 594 | 141 | 735 | 955 | 220 | 63 |
| Total | Producer | 348 | 105 | 453 | 589 | 136 | 43 |
| Channel III | Wholesaler | 589 | 115 | 704 | 588 | 184 | 58 |
| Total | Producer | 348 | 105 | 453 | 589 | 136 | 38 |
| Channel IV | Retailer | 883 | 45 | 928 | 971 | 43 | 12 |
| Total | Producer | 348 | 45 | 393 | 527 | 134 | 39 |
| Channel V | Wholesaler | 686 | 97 | 783 | 888 | 105 | 30 |
| Retailer | 888 | 45 | 933 | 971 | 38 | 11 |
| Total | Producer | 348 | 45 | 393 | 527 | 134 | 43 |
| Channel VI | Wholesaler | 713 | 85 | 798 | 883 | 85 | 27 |
| Total | Producer | 348 | 45 | 393 | 527 | 134 | 35 |
| Channel VII | Retailer | 755 | 95 | 850 | 971 | 121 | 32 |
| Total | Producer | 348 | 45 | 393 | 527 | 134 | 35 |

One USA $ is equal to 37 birr of Ethiopia at survey time.
producer’s share is consistent with theory, as the number of agent’s increase’s the amount of share received by the producer’s will decreases. The results also indicates maximum (38%) of consumer’s price goes to retailers in channel II, followed by wholesalers which was 34% in channel III. Generally, producers obtained higher percentage share of profit when they sold their products to consumers. The finding is in support of Aemro (2018) who indicated unfair distribution of consumers’ price between tomato farmers and the market chain actors. Similarly, Kudzai (2017) explained that only few percent of consumer’s price reaches tomato growers.

3.6.3. Marketing margins of cabbage at different channels

As presented on Table 11, marketing margins of cabbage for particular marketing agents was addressed. The result indicates that total gross marketing margin (TGMM) is highest (66%) in channel III and lowest (28%) in channel II. Producer’s share (GMMp) was uppermost (66%) in channel II, in contrast it is lowest in channel III with share of 34 %. The great portion of gross marketing margin is obtained by retailers which accounts 48% of the consumer’s price in channel VII, followed by wholesalers which was 37% in channel VI.

3.6.4. Major constraints hindering vegetable producers

A lots of constraints were cited during informal survey (focus group discussion and key informant interview) in addition to informal survey data were obtained on bottle necks of vegetables production and marketing. The prominent constraints of vegetable production and marketing were presented on Table 12.

Input supply problem: The most important physical inputs for vegetable production are improved seeds, fertilizers, pesticides and herbicides. Regarding the input supply constraints (shortage of good quality seeds, Table 8. Profit margin and share of profit along cabbage marketing chain/100kg of produce.

| Channel   | Actors | Input/purchasing cost | Marketing cost | Total cost | Selling price | Profit margin | Share of profit (%) |
|-----------|--------|------------------------|----------------|------------|---------------|---------------|---------------------|
| Channel I | Producer | 183 | 135 | 318 | 616 | 298 | 100 |
| Total     |          |             |                |            |               |               |                     |
| Channel II| Producer | 183 | 125 | 308 | 540 | 232 | 67 |
| Retailer  | 540     | 95          | 635            | 750        | 115           | 33            |
| Total     |          |             |                |            |               |               |                     |
| Channel III| Producer | 183 | 25 | 208 | 263 | 82 | 23 |
| Collector | 263     | 75          | 338            | 392        | 54            | 15            |
| Retailer  | 607     | 70          | 677            | 770        | 93            | 26            |
| Total     |          |             |                |            |               |               |                     |
| Channel IV| Producer | 183 | 90 | 273 | 411 | 138 | 41 |
| Collector | 411     | 75          | 501            | 607        | 106           | 31            |
| Retailer  | 607     | 90          | 677            | 770        | 93            | 28            |
| Total     |          |             |                |            |               |               |                     |
| Channel V | Producer | 183 | 90 | 273 | 411 | 138 | 52 |
| Total     |          |             |                |            |               |               |                     |
| Channel VI| Producer | 183 | 25 | 208 | 263 | 82 | 29 |
| Collector | 263     | 75          | 338            | 392        | 54            | 19            |
| Retailer  | 392     | 85          | 477            | 625        | 148           | 52            |
| Total     |          |             |                |            |               |               |                     |
| Channel VII| Producer | 183 | 90 | 273 | 411 | 138 | 37 |
| Total     |          |             |                |            |               |               |                     |

Table 9. Market concentration of selected vegetable traders’

| Number of Trader | Potato | Tomato | Cabbage |
|------------------|--------|--------|---------|
| Market volume (ton) | Market Share (%) | Market volume (ton) | Market Share (%) | Market volume (ton) | Market Share (%) |
| 1 | 580.3 | 4.64 | 563.2 | 6.36 | 1445 | 10.05 |
| 1 | 1273.3 | 10.18 | 885 | 9.99 | 1376 | 9.57 |
| 1 | 1499 | 11.99 | 289.9 | 3.27 | 776 | 5.40 |
| 1 | 698 | 5.58 | 644.4 | 7.27 | 767.1 | 5.33 |
| 1 | 688.4 | 5.50 | 807.6 | 9.11 | 1245.1 | 8.66 |
| 1 | 560 | 4.48 | 777.8 | 8.78 | 1589 | 11.05 |
| 1 | 1424.5 | 11.39 | 564.4 | 6.37 | 967.4 | 6.73 |
| 1 | 1136.1 | 9.08 | 876.6 | 9.89 | 687.7 | 4.78 |
| 1 | 564.1 | 4.51 | 345.6 | 3.90 | 579 | 4.03 |
| 1 | 586.6 | 4.69 | 243.1 | 2.74 | 568.8 | 3.95 |
| 1 | 437 | 3.49 | 456.5 | 5.15 | 1035 | 7.20 |
| 1 | 574.5 | 4.59 | 542.8 | 6.13 | 987.6 | 6.87 |
| 1 | 786.5 | 6.29 | 642.8 | 7.25 | 548.2 | 3.81 |
| 1 | 678.6 | 5.43 | 323.4 | 3.65 | 367.5 | 2.56 |
| 1 | 564.3 | 4.51 | 395.5 | 4.46 | 862.4 | 6.00 |
| 1 | 455.2 | 3.64 | 502.4 | 5.67 | 578.2 | 4.02 |
| Total | 12506.4 | 100.00 | 8861 | 100.00 | 14379 | 100.00 |

Table 10. Purchasing and selling strategy of trader.

| Price setting mechanism | Traders |
|-------------------------|---------|
| Total (%) | Collectors (%) | Wholesalers (%) | Retailers (%) |
| Market (supply& demand) | 50.8 | 52.3 | 45.8 | 54.4 |
| Discussion with other traders | 12.2 | 12.2 | 7 | 17.3 |
| Negotiate with suppliers | 28 | 24.5 | 40.5 | 19.2 |
| Traders themselves | 9 | 11.1 | 6.7 | 9.1 |

As presented in Table 11, marketing margins of cabbage for particular marketing agents was addressed. The result indicates that total gross marketing margin (TGMM) is highest (66%) in channel III and lowest (28%) in channel II. Producer’s share (GMMp) was uppermost (66%) in channel II, in contrast it is lowest in channel III with share of 34 %. The great portion of gross marketing margin is obtained by retailers which accounts 48% of the consumer’s price in channel VII, followed by wholesalers which was 37% in channel VI.
inadequate pesticides and herbicides, and high input price) was responded by the farmers. Sample respondents and informal survey participants presented the existence of limited supply of quality seed, statistically about 87.1% of sample respondents confirmed limited access and supply of improved seed as their major production problem (Table 12).

Limited extension services: Training plays paramount role in equipping farmers with skill, moreover it contributes a lot in achieving sustainable development. The vast majority (60.5%) reported that they have never attended training on agronomic practice and post-harvest handling. In addition, results from informal survey shows farmers are not getting adequate service regarding products marketing. The farmers also reported that, they suffer from poor post-harvest handling techniques which is leading to significant economic losses. Furthermore, farmers do not have good storage facilities available at the farm level, and this forces them to sell their product immediately after harvest. About 86.4% of producers reported disease and pest attacks - mainly fungal disease on potato as the major problems in the study area.

Broker’s problem or market interference: Brokers problem is one of the major marketing constraints which affect vegetable producers (Table 12). About 87.1% of producers reported that brokers intervene the transactions of their products. The focus group discussion participants cited that, the brokers manipulate the prices, create market price information asymmetry which enforces the producers to sale their vegetables at the prices set by wholesalers. Sometimes, the farmers have no idea of the price paid by the wholesalers and only accept price offered by the brokers. In case, if the producers are not capable to sell through broker’s network, they forced to sell to local collectors at the lower price due to perishable nature of the product.

Table 11. Marketing margins of selected vegetable at different channels.

| Vegetables | Actors | Cost item | I   | II  | III | IV  | V   | VI  | VII |
|------------|--------|-----------|-----|-----|-----|-----|-----|-----|-----|
| Marketing Margin of Potato | Producer | Purchase price | 272 | 272 | 272 | 272 | 272 | 272 | 272 |
| | Production cost | 272 | 272 | 272 | 272 | 272 | 272 | 272 |
| | Selling price | 567 | 503 | 317 | 501 | 501 | 317 | 317 |
| | GMMP (%) | 100 | 55.5 | 34 | 49 | 62.5 | 40 | 35.5 |
| | Collector | Purchase price | - | - | 317 | - | - | 317 | 317 |
| | Selling price | - | - | 644 | - | - | 644 | 644 |
| | GMMC (%) | - | - | 25 | - | - | 41 | 36.6 |
| | Wholesalers | Purchase price | - | - | 644 | 501 | 501 | 644 | - |
| | Selling price | - | - | 802 | 802 | 802 | 792 | - |
| | GMMW (%) | - | - | 17 | 32.5 | 37.5 | 18.6 | - |
| | Retailer | Selling price | - | - | 907 | 927 | 927 | - | 920 |
| | GMMR (%) | 44.5 | 13.5 | 13.5 | - | - | 30 | - |
| | TGMM (%) | 0 | 45.5 | 66 | 51 | 37.5 | 60 | 65.5 |
| Marketing Margin of Tomato | Producer | Purchase price | 348 | 348 | 348 | 348 | 348 | 348 | 348 |
| | Production cost | 348 | 348 | 348 | 348 | 348 | 348 | 348 |
| | Selling price | 604 | 594 | 589 | 589 | 527 | 527 | 527 |
| | GMMP (%) | 100 | 62 | 66 | 61 | 54 | 60 | 54 |
| | Collector | Purchase price | - | - | - | - | 527 | 527 | 527 |
| | Selling price | - | - | 888 | 883 | 888 | 883 | - |
| | GMMC (%) | - | - | 34 | 33 | 21 | - | - |
| | Wholesalers | Purchase price | - | - | 589 | 589 | 586 | 713 | - |
| | Selling price | - | - | 888 | 883 | 888 | 883 | - |
| | GMMW (%) | - | - | 34 | 33 | 21 | - | - |
| | Retailer | Purchase price | - | 594 | - | 883 | 888 | - | 755 |
| | GMMR (%) | 955 | - | 971 | 971 | - | 971 | - |
| | TGMM (%) | 0 | 38 | 34 | 39 | 46 | 40 | 46 |
| Marketing Margin of Cabbage | Producer | Purchase price | 183 | 183 | 183 | 183 | 183 | 183 | 183 |
| | Production cost | 183 | 183 | 183 | 183 | 183 | 183 | 183 |
| | Selling price | 616 | 540 | 263 | 411 | 411 | 263 | 263 |
| | GMMP (%) | 100 | 72 | 34 | 53.4 | 66 | 42 | 35 |
| | Collector | Purchase price | - | - | 263 | - | - | 263 | 263 |
| | Selling price | - | - | 392 | - | - | 392 | 392 |
| | GMMC (%) | - | - | 17 | - | - | 21 | 17 |
| | Wholesalers | Purchase price | - | - | 392 | 411 | 411 | 392 | - |
| | Selling price | - | - | 607 | 607 | 625 | 625 | - |
| | GMMW (%) | - | - | 28 | 25 | 34 | 37 | - |
| | Retailer | Purchase price | - | 540 | 607 | 607 | - | 392 | - |
| | GMMR (%) | 595 | - | 971 | 971 | - | 971 | - |
| | TGMM (%) | 0 | 28 | 21 | 21 | - | - | 48 |

where: GMMP = Gross Marketing Margin for producers, GMMC = Gross Marketing Margin for collectors, GMMW = Gross Marketing Margin for wholesalers, GMMR = Gross Marketing Margin for retailers.
4. Conclusion and recommendations

4.1. Conclusion

The benefit-cost ratio analysis has shown that potato, tomato and cabbage production is profitable. The producers supply their vegetable products to wholesalers, retailers, collectors and consumers. The retailers are generating maximum profit margin than other actors in vegetable market chain, while the producers are more profitable when they directly sell to the consumers. The market structure for potato, tomato and cabbage production is weak oligopolistic market structure. The marketing agents are the principal decision makers in setting vegetable prices. Producers obtained higher percentage share of margin when they sold their product directly to consumers. The vegetables sector is hindered with inadequate supply of inputs, under developed vegetables post-harvest handling and poor market information flows.

4.2. Recommendations

Based on the finding the following core recommendations are forwarded to improve vegetables profitability and market performance. The overall profitability analysis shows that there is a positive gross profit margin and there is a room to enhance the profitability of vegetable production through increasing vegetable productivity and reasonable price. Government and non-governmental organizations should strengthen vegetable production extension services through using digital information dissemination. There was a need to reduce market intermediaries to minimize the marketing margins, reduce unfair profit distribution and thereby enhance the producers’ income. Concerning bodies should improve the input supply system so that farmers receive the right type of inputs, quantity and quality needed at the right time. The presence of vegetable diseases created frequent yield reduction and hampered market supply. Therefore, the Ethiopian agricultural research institutes and universities should play crucial role in releasing high yielding and disease resistant varieties to improve production and productivity of vegetables in the study area.

Declarations

Author contribution statement

Ibrahim Aliyi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Abduselam Fari; Assefa Ayele; Alemayehu Oljira; Mulubrihan Bayessa: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data will be made available on request.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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