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ASSESSMENT OF PRODUCTION POTENTIALS FOR POTATO AND TOMATO VEGETABLES IN TIYO AND ZIWAY-DUGDA DISTRICTS OF ARSI ZONE, ETHIOPIA

Agriculture

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ABSTRACT

Vegetable crops have high potential towards household food security, local industries, natural resources base conservation and market stability. In line with this, many vegetable crops are the untapped resources that can be improved and utilized towards the betterment of the livelihood of the people. However, there are many challenges in production and utilization of vegetables to improve their productivity and income in Ethiopia. Thus, the study was undertaken to assess potentials, production inputs and services for tomato and potato in two Districts (Ziway-Dugda and Tiyo) during 2022. Data were collected from 400 households in ten kebeles(local administrative) of both districts and analyzed using SPSS version 22. The study results revealed that the farmers in the study areas produced various crops in addition to tomato and potato vegetables with varied experiences, and produced an average yields of tomatoes (621 quintal ha-1) and potatoes (46 quintals ha-1) with better total revenues (116,994 Birr and 41,290 Birr) by selling the two vegetables produced during the 2020/21 cropping season, respectively. Many farmers in the study areas had various potentials and inputs for production of tomato and potato crops like land access (own and rented); farming practices by changing crops, rotating, changing investment types, and other resources; livestock potentials; various inputs like machineries, seeds, fertilizers, irrigation schemes; and various services available like skills, training and extension advices for vegetables production. However, some farmers in the study areas had not got the aforementioned potentials and resources/inputs to be productive in their vegetables cultivation during the last cropping seasons which needs further interventions in the near future years. Thus, it is possible to conclude that there are many production potentials, inputs and services used by farmers for vegetables production in the study areas even though some farmers had not accessed potentials for production of vegetables that reduced their productions which needs future interventions to capacitate them through training, inputs and services supply and technology adoption.

KEYWORDS

Farming inputs, potato, production potentials, services, tomato, Tiyo, Ziway-Dugda

1. INTRODUCTION

Agriculture is the principal sector in the national economy and in the livelihood of rural Ethiopia. About 17% population lives in urban areas, while 83% population lives in rural area and engaged in agriculture which constitutes over 50% of the gross domestic product (GDP), accounts for over 85% of the labour force, and generates over 90% of the foreign exchange (ECA, 2016; Welteji, 2018). According to FAO report to meet the growing demand, World food production will need to increase by 50% by 2030 (FAO, 2014). Ethiopia has got an immense potential to develop intensive horticulture on small scale as well as on commercial scale. Some of the favourable factors that contribute to an overall investment are diverse agro-ecology that permits different agricultural systems and production of different crops. The existence of this diverse agro-ecology together with diverse farming systems, socio-economic, cultures and climate zones provided Ethiopia with various biological wealth of plants, animals, and microbial species especially crop diversity (Atnaf *et al*., 2015).

Horticultural crops especially vegetables and fruits can contribute to food and nutritional security demands in Ethiopia by providing healthy and sustainable foods for consumers due to their rich source of vitamins, minerals and antioxidants (Emana *et al*., 2015). Ethiopia can benefit considerably from vegetable and fruit production as the country has favourable agro-ecologies and soil for growing diverse vegetable and fruit crops such as tomato, onion, potato, mango and avocado (Yimer and Sahu, 2014; Hunde, 2017). Some nutritional deficiencies like vitamin A and C, and iron can be corrected by use of selected vegetable and root crops as well as fruits; and vegetables not only form an essential part of a well-balanced diet, but the flavor, aroma, color, and anti-oxidant activities also make them important in human diet and appetite (WHO, 2013).

However, farmers growing vegetable crops are facing challenges of production inputs, skills and technologies, high economic and quality losses, because there have been no methods of such improved production potentials and practices suitable in increasing the shelf life and quality of these crops and market access to generate income from vegetable crops. Despite the existence of huge opportunities, the vegetable sector is still underdeveloped due to inadequate farmers' skill in production and management of vegetable production like low technical practices in using production potentials, agronomic, fertilization, management and irrigation technologies and poor knowledge in applying improved agronomic practices and inputs; shortage of practice oriented training systems in production, management, processing and marketing of vegetables; and lack of organized systems in vegetable marketing to boost producers bargaining power in price negotiations (Kasso and Bekele, 2018).

There is a need to identify potentials, inputs and services limiting

production and productivity of vegetables; to know a production status of the local farmers for further capacitating producers' skills and knowledge; and to recommend better intervention strategies for vegetables production in some districts of Arsi zone, Oromia-Ethiopia. It is imperative to understand what is known and what can be done, and what are actually available potentials and resources for farmers in the zone. Even though the zone is an ideal place for market oriented horticultural crops, the sector is subsistence and low level of development in access and utilizing to modern production and management technologies, market, and improved variety hinders productivity (Mekonen, 2012).

1.1. OBJECTIVES:

- To have baseline data on potato and tomato vegetables production potentials in Tiyo and Ziway-Dugda Districts.
- To assess production inputs and services for vegetables productivity in the study areas and to identify capacities required for producers to develop future intervention strategies.

1.2. Significance of the Study

This study generated important information useful to formulate vegetable crops production potentials used by farmers; inputs and services available to produce vegetables and enhance their productivity; programs and guidelines needed for interventions that would improve efficiency of the vegetable crops production system in the study areas. The potential users of the results of this study would be researchers, development organizations, farmers, traders, policy makers, and extension service providers, governmental and non-governmental organizations, scholars and graduates who want to introduce interventions of vegetables crops production and management. Furthermore, this study might be used as a base references for further researches.

1.3. Scope and Limitation of the Study

This study was conducted in two districts of Arsi zone, Oromia Regional State, Ethiopia with general horticultural commodities and specific crop category of vegetables (Tomato and Potato) within one year time boundary of base line study. The data covered only ten rural "kebeles" and 400 households. The study was limited to the assessment of productivity potentials, inputs and services utilized by farmers that analyzed the performance of farmers in vegetable crops production in the districts. Also, the study might have been limitations of making generalizations and making them applicable to overall zone and the country. The study also did not assess the field production and management activities.

2. Research Design And Methodology

2.1. Description of Study Areas

This study was conducted in Arsi Zone, Oromia Regional State-Southeastern Ethiopia in two potential vegetable crops producing districts (namely Tiyo and Ziway-Dugda Districts) in both irrigation and rain-fed production areas (Tables 1). The districts are more known in vegetable crops production and productivity in the Zone as the previous data of the zone indicated. The districts are located surrounding central city of the zone, Asella/Arsi University/, which is found at 175km Southeast of Addis Ababa. The districts include high lands, middle and low lands (AZADO, 2016).

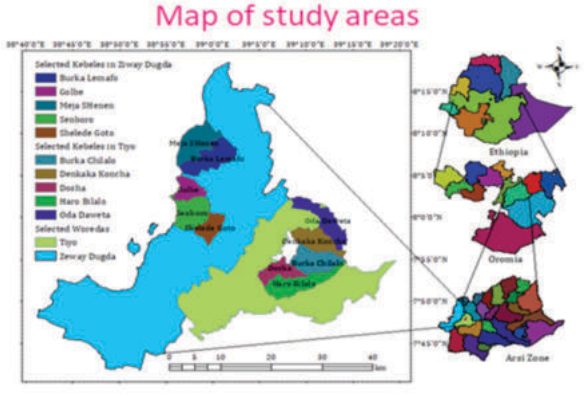

Figure 1: Location of study areas

Table 1: Quantitative production of horticultural crops in terms of acreage coverage

S.No	District Name	Irrigation production of horticulture crops (ha), 2015	Total production of horticulture crops (ha), 2015	Production of horticulture crops (ha), 2016	Remarks
1	Tiyo	2263	3612	4916	Study area
2	Ziway-Dugda	10836	17708	20972	Study area

Source: AZADO, 2016 (Arsi Zone Agriculture Development Office report, 2016)

2.2. Research Design and Population of the Study

Survey type of research design was used to conduct this baseline study. The population of the study covered the two districts of the zone which were selected purposively because of they are known in vegetable crops like potato and tomato production from 24 districts of Arsi Zone. The target populations of the study were also covered about 10 kebeles producers which were randomly selected in each kebeles in the study areas. According to data obtained from the two districts' Irrigation Development Authority Offices; totally there were 90933ha of land produced in the zone using various irrigation types during 2016/17 production year (AZADO, 2017).

2.3. Sampling Techniques

The study used multistage sampling techniques to select representative potato and Tomato producer farmers in the study areas. In the first stage Tiyo and Ziway districts were selected purposively based on potential and agroecologically suitable for potato and Tomato production respectively. Both Tiyo and Ziway-Dugda districts are among the potential districts identified for potato and tomato producing districts of Arsi zone, respectively (Arsi zone district office of agricultural data, 2022). In the second stage, out of the 23 rural kebeles in Tiyo district five kebeles were selected by simple random sampling techniques. The randomly selected kebeles were Dosha, Hora Bilalo, Oda Dawata, Burka Chilalo, and Denkaka Konicha. In similar way, from Ziway-Dugda district, Burka Lemeffo, Sembero, Meja Shanen, Shalad Goto, and Golbe were randomly selected (Table 2).

In the third stage, based on the population of potato producers' household number in their respective kebeles and applying Yeman (1967) formula, 209 and 191 sample potato and tomato producer farmers were selected for this study, accordingly. By applying proportional allocation for each kebele based on their population of potato producer kebeles, the following sample size farmers of potato and tomato were selected randomly (Table 2). The level of precision was 5% while calculating the sample size.

Yemane formula

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Potato farm household's Sample size at Tiyo district is

$$n = \frac{N}{1+N(e)^2} = \frac{439}{1+439(0.05)^2} = 209$$

Tomato farm household's Sample size at Ziway-Dugda district is

$$n = \frac{N}{1+N(e)^2} = \frac{367}{1+367(0.05)^2} = 191$$

Table 2: Name of sampled kebeles and their respective Sample size

Districts and crops produced	Name of kebele	Sample size
	Dosha	54
Tiyo/ Potato	Hora Bilalo	33
	Oda Dawata	37
	Burka Chilalo	42
	Denkaka Konicha	43
	Sub-total 1	209
Ziway-Dugda/Tomao	Burka Lemeffo	62
	Sembero	32
	Meja Shanen	8
	Shalad Goto	50
	Golbe	39
	Sub-total 2	191
	Grand Total	400

Source: Data from researcher's calculation of the study areas

2.4. Data Collection and Sources

In order to meet the objective of the baseline study of the project, the data required for the study were collected from primary data sources. Primary data were collected from producers. For primary data collection methods semi-structured interview schedule or interview guided questionnaires were developed in KOBO Software using tablet computer.

To collect primary data enumerators (academic staff) working in the university were selected and trained on how to conduct and approaches interviewing the sample members for each sample categories. The researchers preferred academic staff because of they have close relationship with the study and producing farmers since they are working together and that helps to avoids on response due to doubtful and worries and to minimize the technical errors. Also they knew the English version of questioners and asking orally in local languages (Afaan Oromo and Amharic).

Districts Development Agents and Agriculture Development Offices experts were also used to help the facilitation of data collection and contacting farmers in the study. Secondary data was collected from government organizations such as Districts and Zonal Irrigation Development Offices and Agricultural Development Offices, and literatures like magazines, journals, previous research report, etc.

2.5. Methods of Data Analysis and Procedures

The questionnaires were checked for clarity and consistency in answering questions. Statistical package for social science (SPSS) version 22 and STATA version 16 were used for computing data recorded by KOBO. These collected data were analyzed using percentages, means, Standard deviation, and tabulated in the process of examining and describing production potentials, resources, inputs and services in the study areas.

3. RESULTS AND DISCUSSION

3.1. Demographic and Socio-economic characteristics of sample households

Sex of respondent household:

of the total sample households, 81.5% and 18.5% were male and female household, respectively. Male respondent households represented about 73.7% and 90% from Tiyo district (potato producers) and Ziway-Dugda district (tomato producers), respectively; whereas, female respondent households represented about 26.3% and 10% from Tiyo district (potato producers) and Ziway-Dugda district (tomato producers), respectively. The Chi square value (17.73) was significant at 1% probability level (Table 3). Thus, there was a significant difference between Tiyo district (potato producers) and Ziway-Dugda district (tomato producers), with regards to the sex of household respondents.

Marital status of the respondent households:

With regards to the marital status, from the total sample respondents, 90.75%, 5.75%, 2.75% and 0.75 % were married, single, widowed and divorced, respectively. There was a significance difference between Tiyo district (potato producers) and Ziway-Dugda district (tomato producers), in terms of marital status. The Chi square value (12.07) was significant at 1% probability level (Table 3). Thus, there was a significant difference between Tiyo district (potato producers) and Ziway-Dugda district (tomato producers), with regards to marital status of the household respondents.

Educational status of the respondent households:

The baseline survey results revealed that 93% of the respondent households were can read and write; whereas, 7% were can't read and write. In Tiyo district (potato producers), 92.34% and 7.7% of them were literate and illiterate, respectively; whereas, in Ziway-Dugda district (tomato producers) 93.71% and 6.3% were literate and illiterate, respectively. There was no significant difference between potato and tomato producers in terms of their literacy level (Table 3).

Figure 2 showed significant variations in education levels of those literate sample household heads. More house hold heads were learned till grade ten (17.8%), only 6.5% of them have completed grade 12 education and 39.8% of the respondents were learned only primary education level.

Table 3: Characteristics of sample households by sex, marital status and literacy level

Characteristics		Tiyo District (Potato) (N=209)		Ziway-Dugda District (Tomato) (N=191)		χ2 –Value	Total sample (N=400)	
		N	%	N	%		N	%
Sex of respondent:	Female	55	26.3	19	10	17.73***	74	18.5
	Male	154	73.7	172	90		326	81.5
	Total	209	100	191	100		400	100
Marital status:	Married	197	94	166	87	12.07***	363	90.75
	Widowed	6	3	5	2.6		11	2.75
	Single	4	2	19	10		23	5.75
	Divorced	2	1	1	0.5		3	0.75
	Total	209	100	191	100		400	100
Literacy level:	Can't read and write	16	7.7	12	6.3	0.301	28	7
	Can read and write	193	92.34	179	93.71		372	93
	Total	209	100	191	100		400	100

Source: Baseline survey data computation result (2022)

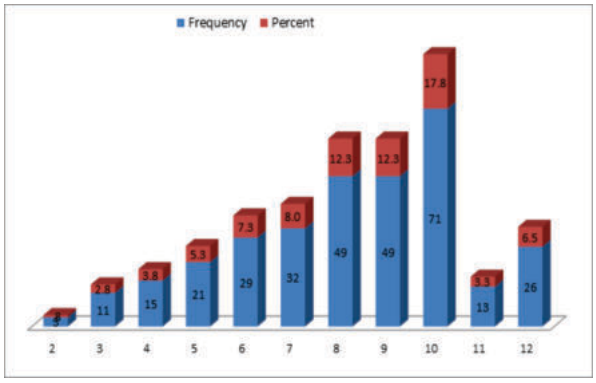

Figure 2: Education levels of household head in years of schooling for literate

Age of the household heads:

Age of the total sample respondents ranged from 14 to 84 years with mean of 40 years and standard deviation of 13.16. The average age of the Tiyo district (potato producers) was 43 years, while that of Ziway-Dugda district (tomato producers) was 38 years. The result showed that the mean difference between potato and tomato producers with regard to age was statistically significant at 1% probability difference (Table 4).

Family size of sample households:

Family size of the total sample respondents ranged from 1 to 14 persons, with an average family size of 6 and a standard deviation of 2.76. The average family size of the potato and tomato producers' households was 5.84 and 6.2, with standard deviations of 3.22 and 4.85, respectively. However, family size between the two districts was statistically insignificant (Table 4). Moreover, from the total family size almost half of the family size was economically active labor force which indicated that the available family labor from the total family size is half of it and the rest half are independent (Table 4).

Table 4: Distribution of sample households by age, family size and economically active family members

Characteristic	Tiyo District (Potato) (N=209)	Ziway-Dugda District(Tomato) (N=191)	Difference in means	t-value	Total sample (N=400)		
	Mean (SD)	Mean (SD)	Mean		Mean (SD)	Min.	Max.
Age (years)	43 (12.4)	38 (13.43)	5.44	4.21***	40 (13.16)	16	82
Family size (number)	5.84 (3.22)	6.2 (4.85)	0.362	0.638	6.01 (2.76)	1	14

Economically active (work force) family members (number)	3.5 (2.15)	3.3 (1.88)	0.194	0.959	3.4 (2.02)		

Source: Baseline survey data computation result (2022)

3.2. Production Potentials for Vegetables Cultivation

3.2.1. The most stable food and vegetable crops produced in the study areas

The total amount of stable food crops and vegetables crops produced in the study areas (Tiyo and Ziway-Dugda Districts) during the cropping season of 2020/21 by the producers was differed in terms of quantity. The most important stable food crops produced in the two districts were maize (40%) and Barley (37%) of the total 400 respondent households; only 12%, 9.5% and 1% of the respondent farmers produced wheat, teff and sorghum as an important food crops in the two districts, respectively in the production season 2020/21 which is in small amount as compared to maize and barley crops produced (Figure 3). On average, about 52% producers have cultivated potato and 48% respondents have produced tomato crop according to the respondents in the study districts (Figure 4). Farmers in the two districts produced the largest proportion of maize, barley, tomato and potato crops both for consumption and market. This showed that cereals and vegetable crops were produced mainly for home consumption and selling at market in order to generate income from their farms. The study indicated that crops producers in Tiyo and Ziway-Dugda districts have produced more highlands (Potato and Barley) and lowlands (Tomato and Maize) adopted crops, respectively (Figures 3 & 4). According to Belachew *et al*. (2022) maize (6.5 and 8.1 t ha^{-1}), wheat (3.7 and 4.5 t ha^{-1}) and sorghum (3.3 and 4.2 t ha^{-1}) were the most stable crops produced on farm and research station, respectively in Ethiopia.

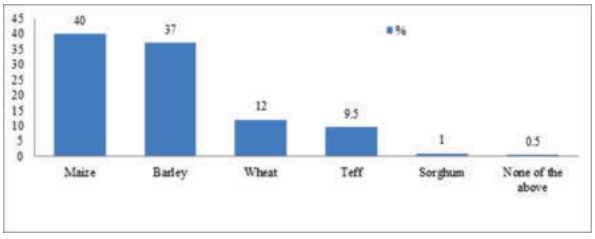

Figure 3: Most staple food crops produced in Tiyo and Ziway-Dugda Districts in 2020/21

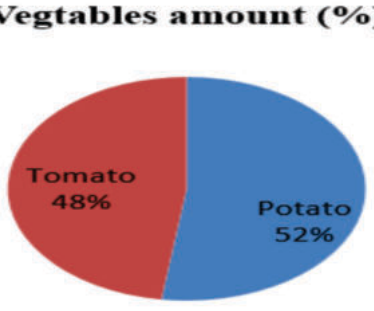

Figure 4: Potato and tomato vegetables produced in Tiyo and Ziway-Dugda districts in 2020/21

Source: Baseline survey data computation result (2022)

3.2.2. Experience and land use for Potato and Tomato production in the study areas

Farmers in the study areas had various experiences on tomato and potato production ranging from 1 to 40 years and from 1 to 60 years in Ziway-Dagda and Tiyo districts with an average of 7 and 14 years, respectively (Table 5). This indicated that farmers at Ziway-Dagda district have started tomato production in near years (half of experiences for potato), but farmers found in Tiyo district has been participated on potato cultivation for about 14 years. However, the potato farming experience of all sample farm households of Farta District in South Gondar Zone of Amhara National Regional State of Ethiopia was double of the current finding (27.51 years) (Wubet *et al*., 2022).

The total and rented amounts of land operated by the farmers were showed variations in the cropping year of 2020/21 for vegetables production in the two studied districts (Tables 5). Farmers living in the two districts were rented land (30.25%) in the 2020/21 cropping season for tomato and potato vegetables production. Higher land (mean 1.37 ha) was rented by farmers participated on tomato cultivation in Ziway-Dugda district as compared with those has been participated on potato cultivation in Tiyo district (0.53ha). The total land allocated for cultivation of potato and tomato in the 2020/21 cropping season was also varied within farmers in both districts ranging from 0.25 to 6 ha for potato and 0.125 to 20 ha for tomato with an average of 1.78 ha and 2.07 ha, respectively (Table 5). Larger lands and mean values were allocated for tomato as compared to potato crop. This indicated that availability of variation within producers in terms of allocating land for vegetables production and also across crop type which might be due to various factors affecting production of tomato and potato crops like awareness about productivity of vegetables, availability of land and cost of renting land, market access for perishable commodities, abiotic and biotic factors and various inputs and technologies required for vegetable crops cultivation. Similarly, Wubet *et al*. (2022) reported that from the total land owned (2.71 ha) by sample households, small land amount (0.74 ha) was allocated for potato production. During the production year of 2015/2016, it ranked first in area coverage and third in both total production and productivity among the root crops grown in Ethiopia (CSA, 2016).

The rates of money paid to rented land for both tomato and potato cultivation was ranged from 2,500 to 140,800 Birr and 0 to 50,000 Birr with mean values of 31,640 and 12,750 Birr per hectare of rented land (Table 5). This might be due to the farmers in both districts are known by cultivation of cereals mainly during rainy season, but vegetables were mostly produced during dry season using irrigation that made land to rent more costly in addition to irrigation and other agronomic costs.

Table 5: Years of experience and land allocated to potato (Tiyo) and tomato (Ziway-Dugda) production in the last cropping season of 2020/21 (Descriptive Statistics)

Factors	Crops	N	Min.	Max.	Mean	Std. Deviation
• Experience in production (Years)	• Tomato	191	1.00	40.00	7.0	6.92
	• Potato	209	1.00	60.00	14.0	9.88
	• Total respondent	400				
• Land amount rented to cultivate (ha)	• Tomato	52(191)	0.125	5.50	1.37	1.32
	• Potato	69(209)	0.063	4.00	0.53	0.73
	• Total respondent	121(400)				
• Total area used during 2020/21 cropping season (ha)	• Tomato	191	0.125	20.00	2.07	2.04
	• Potato	209	0.250	6.00	1.78	2.05
	• Total respondent	400				
• Money paid for rented land (Birr)	• Tomato	52(191)	2500	140800	31640.38	31528.22
	• Potato	69(209)	0.00	50000	12750.73	12490.41
	• Total respondent	121(400)				

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.2.3. Tomato production, consumption and income

The total amount of tomato crop produced, allocated for consumption and supplied to the market for revenue by selling produces by the producers was differed in terms of quantity and level of returns. Amount of tomato produced was varied from 5 quintals to 1600 quintals with an average amount of 182 quintals per ha in the study area (Ziway-Dugda district). The national average yield of tomato was 65.20 quintal per hectare in 2020/21 meher season (CSA, 2021). On average, tomato crop producers sold about 150.96 quintals and kept for home consumption about 3.17 quintals which was ranged from 0 to

100 quintals of their total harvested produce (Table 6). Also they have responded that from 1-350 quintals of their total produce were wasted at field and during transportation to the market with an average of 28 quintals which is about 15% of the total produced (Table 6). This indicated that many of their tomato produces were wasted at various value chain of the crop and lack of sophisticated handling, storage and transportation facilities for perishable tomato fruits; but their household consumption amount was low as compared to their level of production and wastage. On average only 1.74%, 2.10% and 11.33% of the total produced tomato were consumed in home as compared to the amount of tomato produced, sold and wasted at various value chain of the commodity, respectively.

Average tomato selling prices were also significantly varied across producers in the study area; ranged from 50 to 5000 Birr per quintal based on quantity, quality and market access for the produce. The interviewed farmers have sold their tomato fruit on average 1143.21 Birr per quintal in the district during production season of 2020/21. Those farmers produced largest proportion of tomato in the district and sold the crop to the market has got better returns as compared those not participated in the crop cultivation. As the study result indicated the total revenue from tomato production and selling was ranged from 1800 Birr to 2,583,000 Birr with an average of 184,276.32 Birr during the last production seasons. These showed that vegetable crops were productive and maintain market income in addition to securing nutritional status for family. The study indicated that producers of tomato crop in Ziway-Dugda district had got more returns by supplying to market more than those consumed in home (Table 6).

Table 6: Average yield of tomato production, consumption and marketing in the Ziway-Dugda district in the cropping year of 2020/21(Descriptive Statistics)

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Amount of tomato harvested (Quintal)	191	5	1600	182.12	296.66
Amount of tomato sold from the harvested (Quintal)	191	3	1435	150.96	256.61
Amount of tomato kept for household consumption from harvested (Quintal)	191	0	100	3.17	8.27
Amount of tomato wasted at field and during transportation to market (Quintal)	191	1	350	28.00	47.49
Average tomato selling price (Birr per quintal	191	50	5000	1143.21	603.42
Total revenue from sale of tomato (Birr)	191	1800	2583000	184276.32	351750.87

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.2.4. Potato production, consumption and income

The total amount of potato crop produced, allocated for consumption and supplied to the market for return by selling produces by the producers was varied in terms of quantity and returns. Amount of potato produced was varied from 8 to 248 quintals with an average amount of 64.36 quintals in the study area (Tiyo district). However, compared to the current finding, the mean potato produced was higher (82.22) at Farta district (Wubet *et al*., 2022). The national average yield of potato was 132.79 quintal per hectare in 2020/21 meher season (CSA, 2021). This indicated that the average yield of potato in the study district was lower than the national average yield by 48%. On average, potato crop producers have sold an amount of 45.49 quintals and kept for home consumption about 3.40 quintals which was ranged from 0 to 20 quintals of their total harvested produce (Table 7). Also they responded that from 0-20 quintals of their total produce were wasted at field and during transportation to the market with an average of 5.21 quintals (Table 7). This indicated that many of their potato produces were wasted at various value chain of the crop and lack of modern handling, storage and transportation facilities for perishable potato crop; but their household consumption amount was low as compared to their level of production and wastage. On average only 10%, 12% and 142% were consumed in home as compared to the amount of total potato produced, sold and wasted at various value chain of the commodity, respectively.

Average potato selling prices were also significantly varied across producers in the study area; ranged from 100 to 3,000 Birr per quintal based on quantity, quality, market access for the produce and purposes of tubers. Farmers have sold their potato tuber with an average 947 Birr per quintal in the district during production season of 2020/21. Those farmers produced largest proportion of potato in the district and sold the crop to the market got better returns as compared to those not participated in the crop cultivation. As the study result indicated the total revenue from potato production and selling was ranged from 800 Birr to 792,000 Birr with an average of 41,290 Birr during the last production seasons. These showed that vegetables were more productive and increased income from marketing their produce in addition to creating job opportunity for family. The study results indicated that potato producers in Tiyo district have got more returns by supplying to market more than those consumed at home (Table 7).

Ethiopia has possibly the highest potential for potato production than any country in Africa with 70% of the 13.5 million ha of arable land suitable for potato cultivation. Over one million highland farmers could grow potatoes in Ethiopia. Two of the three known agro-ecologies Woyina Dega (1500–2300 masl) and Dega (above 2300 masl) exhibit the best out-grower potato production (Tesfaye, 2008); it was estimated that 296,577.59 ha was planted and 36,576,382.69 qt produced annually (CSA, 2016). In Ethiopia, potato is becoming a prominent source of income since the crop is the most important cash crop for smallholder farmers in the mid-altitude and highland areas of the country (Mulatu *et al*., 2005; Gildemacher *et al*., 2009).

Table 7: Average yield of potato production, consumption and marketing in the Tiyo district in the cropping year of 2020/21(Descriptive Statistics)

Variables/Items	N	Min.	Max.	Mean	Std. Deviation
Amount of potato harvested (Quintal)	209	8	248	64.36	41.67
Amount of sold from the harvested potato (Quintal)	209	3	248	45.49	35.46
Amount potato wasted at field and during transportation to market (Quintal)	209	0	20	5.21	4.45
Amount of harvested potato kept for household consumption (Quintal)	209	0	20	3.40	3.20
Average potato selling price (Birr per quintal)	209	100	3000	944.53	369.53
The farmer's total revenue generated from sell of potato (E.Birr)	209	1200	297600	44163.59	42667.68

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.3. Different Inputs used for Vegetable Crops Production

3.3.1. Land access for crops production

Land availability is the major resource for vegetable crops production and productivity of farm outputs, and to increase family income specifically and GDP of the country in general. Having land is the first step of preparation for farming any type of crop and to be productive in their farming system. Farmers in the study areas were obtained farming lands in different ways for cultivating vegetable crops. More farmers had their own lands (27.25%) followed by those had inherited from their families (25%) and obtained through gift from their relatives (23%). Other farmers had obtained lands for cultivation of crops through lease/rent (14%), from family (7.25%), share tenancy (3%) and other ways (0.5%). Farmers had accessed lands in various amounts in either of the above mentioned ways (Table 8).

Table 8: Ways of land accessed by farmers in the study districts (Tiyo and Ziway-Dugda)

Land access		Number	%
Operated land obtained in the following ways in the last cropping seasons	Own land	109	27.25
	Inherited	100	25.00
	Gifted	92	23.00
	Leased or rented	56	14.00

	Family land	29	7.25
	Share tenancy	12	3.00
	Other (contract)	2	0.50
	Total	400	100.0

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.3.2. Livestock potentials of farmers for crops production

Livestock are capital assets and investment in livestock raises farm production through extension of the area of land area that can be utilized, diversification of the productive activity on a crop farm and intensification (by raising livestock value of output and hence total production per hectare of agricultural land increases). Availability of farming animals is potentials for vegetables cultivation both in utilization for ploughing the land and as sources of organic fertilizers for vegetables fertilization. Farmers in the study areas had potentials in livestock resources and 92.25% (369) of the respondents had these potentials on their farms (Table 9). These indicated that farmers in the study areas have been undertaking mixed farming system of agriculture. In addition to cultivating vegetables by modern machineries they could produce vegetables also by ploughing with oxen and other farm animals. The mean values of various domesticated animals are substantiating the capacity of farmers had produced vegetables on their farm lands in the last cropping seasons (Table 9). Farmers had 0 to 10 oxen in their farms with an average of 2.2 oxen per household in the last cropping year (Table 9); which indicated that they have capacity to cultivate vegetables and to improve their livelihoods and family consumption. However, the mean oxen available for potato production at Farta district was lower (1.94) as compared to the current finding (Wubet *et al*., 2022).

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.3.3. Farming machineries and inputs access for vegetables production

Farmers in the study areas have been responded that there were variations in use of machineries for vegetables cultivation in the last cropping season. They had used drought-oxen, knapsack sprayer, tractor plough, water-pump, safety equipments for farm workers, generator, other irrigation equipments, row seeder, mulching and wheelbarrow for vegetables production. Out of 400 sample respondents in the two districts, 342(85.5%), 173(43.25%) and 153(38.25%) households have used drought-oxen, knapsack sprayer and tractor plough for their vegetables cultivation (Table 10). Others have used water pump (23.5%), safety equipment for farm workers (20%), generator (17.25%), other irrigation equipments (13.75%), row seeder (9.5%), mulching (5.75%) and wheelbarrow (2.25%) for vegetables cultivation (Table 10). However, there were various respondents not used the aforementioned machineries for vegetables production ranging from 14.5% (drought-oxen) to 97.75% (wheelbarrow) (Table 10).

Farmers has changed their farming inputs in the last cropping year like using new seeds/varieties (84.25%), using more fertilizer for cultivation (65.25%) and new livestock breeds (22.25%); but only 4.75% of the respondents had not changed these farming inputs (Table 10). However, other respondents were not changed the aforementioned farming inputs for vegetables production like using new seeds/varieties (15.75%), using more fertilizer for cultivation (34.75%) and new livestock breeds (77.75%), respectively (Table 10).

Table 9: Potential livestock resources for vegetables production in the study areas (Statistics)

	Respo nse	Cows (local breed)	Cows (cross breed)	Calves	Heifers	Bulls	Oxen	Sheep	Goats	Horse	Donkey	Mule	Camel	Chicken
Livestock owning	Yes	369	369	369	369	369	369	369	369	369	369	369	369	369
	No	31	31	31	31	31	31	31	31	31	31	31	31	31
Mean		1.35	0.76	1.45	0.84	0.53	2.20	3.03	1.73	0.38	0.97	0.05	0.02	7.13
Median		1.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00	1.00	0.00	0.00	5.00
Mode		0	0	0	0	0	2	0	0	0	0	0	0	0
Std. Deviation		1.797	1.146	1.63	1.19	0.99	1.40	5.05	4.61	0.65	1.06	0.39	0.265	9.17
Variance		3.228	1.314	2.67	1.42	0.99	1.96	25.47	21.28	0.42	1.13	0.16	0.07	84.01
Range		19	6	16	7	6	10	40	53	4	6	6	5	70
Minimum		0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum		19	6	16	7	6	10	40	53	4	6	6	5	70
Sum		498	280	536	310	196	813	1117	637	140	358	18	6	2632

Only very few respondents (2.5%) were reasoned out their farming inputs changed based on the new one has increased productivity, buyers demand, no longer availability of inputs/tools, other opportunities, lack of awareness, lack of finance & information, and absence of more income. Thus, majority of farmers (97.5%) were not responded to the aforementioned reasons on the changes of farming inputs (Table 10).

Farmers in the study area have been responded that there were variations in owning and renting used machines in the last two cropping years for vegetables cultivation. Thus, they have owned (54.25%) and rented (44.75%) used machines in the last two years for vegetables cultivation (Table 10). Out of 400 sample respondents in the two districts, 183(45.75%) and 221(55.25%) did not own and rent used machines in the last two years for their vegetables cultivation, respectively (Table 10).

Table 10: Potential farming machineries and inputs, and utilization of own and rented used machines for vegetables production in the study areas in the last cropping seasons of 2020/21

Variables	Responses/ Items	Yes		No		Total	
		N	%	N	%	N	%
Used machinery in the last cropping season for vegetables production	Draught-Oxen	342	85.50	58	14.50	400	100
	Knapsack sprayer	173	43.25	227	56.75	400	100
	Tractor plough	153	38.25	247	61.75	400	100
	Water-pump	94	23.50	306	76.50	400	100
	Safety equipment for farm workers	80	20.00	320	80.00	400	100
	Generator	69	17.25	331	82.75	400	100
	Other irrigation equipment	55	13.75	345	86.25	400	100
	Row seeder	38	9.50	362	90.50	400	100
	Mulching	23	5.75	377	94.25	400	100
	Wheelbarrow	9	2.25	391	97.75	400	100
Farming inputs changed in the last cropping season	New seeds/varieties	337	84.25	63	15.75	400	100
	More fertilizer	261	65.25	139	34.75	400	100
	New livestock breeds	89	22.25	311	77.75	400	100
	None of them	19	4.75	381	95.25	400	100
Reasons to change farm input in the last cropping season	Productivity increment of the new one	1	0.25	399	99.75	400	100
	Buyers demand	2	0.5	398	99.50	400	100
	Inputs/tool no longer available	1	0.25	399	99.75	400	100
	Opportunity	1	0.25	399	99.75	400	100
	climate change	0	0	400	100	400	100

	Other (lack of awareness, finance & information, no more income, nothing)	5	1.25	395	98.75	400	100
Sources of used machines	Owned used machine in the last 2years	217	54.25	183	45.75	400	100
	Rented used machine in the last 2years	179	44.75	221	55.25	400	100

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.3.4. Types of investment in productive assets used for vegetables production

Farmers in the study area have been responded that there were variations in having investment on productive assets for vegetables cultivation in the last cropping season. They invested on productive assets of new farm implements, rented lands, herd expansion, new machinery, new storage facilities and other assets for vegetables production. Out of 400 sample respondents in the two districts, 193(48.25%), 150(37.5%) and 130(32.5%) households have invested on their productive assets of new farm implements, rented lands, and herd expansion for their vegetables cultivation; but 207(51.75%), 250(62.5%) and 270(67.5%) respondents were not changed their new farm implements, rented lands and herd expansion, respectively (Table 11). Other farmers had investments on new machineries (21%), new storage facilities (12.75%) and other assets (2.75%) for vegetables cultivation (Table 11). However, there were various respondents not had investment on the aforementioned productive assets for vegetables production ranging from 51.75% (new farm implements) to 87.25% (new storage facilities) (Table 11).

Farmers have their own reasons of changing their investment on the assets; 308(77%), 111(27.75%), 89(22.25%), 58(14.5%), 22(5.5%) and 20(5%) respondents have been reasoned out their investment on assets like productivity increment of the new one, buyers demand, new opportunities, older inputs/tools has no longer available, due climate change and others factors, respectively. However, there were other farmers not responded to the aforementioned reasons in their investments on the productive assets for vegetables production: 23%, 72.25%, 77.75%, 85.5%, 94.5% and 95% for the above mentioned reasons, respectively (Table 11).

Table 11: Types of investment in productive assets used for vegetables production in the study areas in the last cropping seasons of 2020/21

Variables	Responses/ Items	Yes		No		Total	
		N	%	N	%	N	%
Types of Investment in productive assets in the last cropping season	New farm implements	193	48.25	207	51.75	400	100
	Rented land	150	37.5	250	62.5	400	100
	Herd expansion	130	32.5	270	67.5	400	100
	New machinery	84	21.00	316	79.00	400	100
	New storage facilities	51	12.75	349	87.25	400	100
	Other (Transportation facilities)	11	2.75	389	97.25	400	100
	None	74	18.50	326	81.50	400	100
Reasons to change investment on assets	Productivity increment of the new one	308	77.0	92	23.0	400	100
	Buyers demand	111	27.75	289	72.25	400	100
	New Opportunity	89	22.25	311	77.75	400	100
	Older Inputs/tool no longer available	58	14.5	342	85.5	400	100
	Climate change	22	5.5	378	94.5	400	100
	Other (price inflation)	20	5.0	380	95.0	400	100

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.3.5.Access and utilization of tomato and potato planting materials

The main types of planting materials used for production of tomato and potato crops were both local and improved seeds and seedlings in the study areas; however, their amounts were varied significantly based on the type of crop and availability of planting materials across farmers. Out of 191 for tomato and 209 for potato crops sample respondents (totally 400) in the two districts, 37(17.8%) and 74(35.4%) households have used local seeds of tomato and potato crops for production, respectively; and 129(67.54%) and 133(63.64%) households have used improved seeds of tomato and potato crops, respectively (Table 12). Only 7(3.67%) and 1(0.48%) have used local seedlings, and 21(10.99%) and 1(0.48%) have used improved seedlings of tomato and potato crops in the two districts of the study areas, respectively (Table 12). These indicates that farmers are mainly using improved seeds of both crops and additional local seeds, but seedlings were available for only tomato crop whether it is local or improved seedlings. According Wubet *et al*. (2022) majority farmers (75.61%) used local and improved potato seeds and 24.39% of the sample farm households have used local seeds.

Availability of the improved variety was significantly varied across households and crops. Thus, more than half of the households have been responded that improved variety of tomato and potato crops was available in enough quantity (53.93% and 48.32%), available but not enough (19.37% and 15.79%) and not used improved variety (21.47% and 0.48%); but about 5.23% and 35.41% of them were responded that no available variety of tomato and potato, respectively (Table 12). Timely availability was also replied by households of the study areas; 86(57.33%) and 53(39.55%) of the farmers were replied that improved tomato and potato varieties were available on time; but 64(42.67%) and 81(60.45%) of them responded as not timely available for cultivation of tomato and potato crops, respectively (Table 12). This might has been impacted their productivity and income and their plan of next year production.

Those farmers used local variety also have raised their reasons: 19(46.34%) and 22(29.33%) respondents have blamed the high cost of improved varieties, 2(4.88%) and 7(9.33%) respondents were not have awareness on improved varieties, 1(2.44%) and 11(14.67%) of them were raised that local varieties are pest resistant, and 1(2.44%) and 15(20%) of them were reasoned out that local varieties have longer shelf life for tomato and potato crops, respectively (Table 12). The rest respondents (43.9% and 26.67%) were not used local varieties of tomato and potato crops in the last cropping seasons, respectively.

The main sources of tomato and potato seeds/seedlings supply in the study areas were: Own saved seeds, primary cooperatives, local market, neighbor farmers, non-governmental organizations (NGOs) and government organizations (GOs) input suppliers. Out of 400 sample respondents (191 for tomato and 209 for potato) in the two districts, 14(7.33%) and 11(5.26%) households have used improved seeds/seedlings of tomato and potato crops during planting from own source, 50(26.18%) and 5(2.39%) from primary cooperatives, 92(48.17%) and 58(27.75%) from local markets, 11(5.76%) and 85(40.67%) from neighbor farmers, 20(10.47%) and 13(6.22%) from non-governmental organizations, and 4(2.09%) and 37(17.70%) from governmental organizations for tomato and potato crops, respectively (Table 12). This implies that tomato producers have got more number of seeds/seedlings from local markets (48.17%) and potato producers have got more seeds/seedlings from neighbor farmers (40.67%) for production of the crops in the last cropping seasons; but lowest suppliers were government organizations and primary cooperatives for tomato and potato crops, respectively. Generally, the results indicated that there were various sources of seeds for cultivation of vegetables. However, Biruhalem (2010) revealed that primary cooperatives are the most important source of rice seed.

Table 12: Types, sources and availability of planting materials of tomato and potato vegetables used in the production season of 2020/21

Variables	Items/ Responses	Tomato		Potato	
		Number	%	Number	%
Type of planting materials used	Local seed	34	17.80	74	35.40
	Improved seed	129	67.54	133	63.64
	local seedling	7	3.67	1	0.48
	Improved seedling	21	10.99	1	0.48
	Total	191	100	209	100
Availability of improved varieties used	Available in enough quantity	103	53.93	101	48.32
	Not used improved variety	41	21.47	1	0.48
	Available but not enough	37	19.37	33	15.79
	Not available	10	5.23	74	35.41
	Total	191	100.0	209	100
Timely availability of improved varieties used	Yes	86	57.33	53	39.55
	No	64	42.67	81	60.45
	Total	150	100	134	100
Reasons for local varieties used	The cost of improved variety is expensive	19	46.34	22	29.33
	I am not aware of improved varieties	2	4.88	7	9.33
	local variety is pest resistant	1	2.44	11	14.67
	local varieties are longer shelf life	1	2.44	15	20.00
	Other & not using local variety	18	43.90	20	26.67
	Total	41	100	75	100
Sources of seeds or seedlings	Own saved	14	7.33	11	5.26
	Primary cooperatives	50	26.18	5	2.39
	Local market	92	48.17	58	27.75
	Neighbor farmers	11	5.76	85	40.67
	Non-Government Organizations	20	10.47	13	6.22
	Government Organizations	4	2.09	37	17.70
	Total	191	100	209	100

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

The amount of seeds and seedlings used in the last cropping season was also significantly varied across the crop and producers in the study districts. Utilized seed mean values of tomato (seed) and potato (tuber seed) was 10.40 kg and 921.80 kg per hectare of land, and 1500 and 6421.65 seedlings were planted on hectare of land for the two crops, respectively (Table 13). Thus, they have spent mean costs of 15,599.59 Birr and 7,618.40 Birr for tomato and potato seeds and seedlings during the last cropping season, respectively (Table 14). Amount of seeds and numbers of seedlings planted were higher in case of potatoes as compared to tomatoes; however, the cost incurred on tomato seeds and seedlings was double that of potato seeds and seedlings cost for planting by farmers in the study areas.

Table 13: Amount of seeds (kg) and seedlings (number) utilized and their costs for tomato and potato crops production in 2020/21

Planting materials	Crop	Frequency	Mean	St. Deviation
Amount of seeds used (kg)	Tomato	191	10.40	65.52
	Potato	209	921.80	1815.85
Amount of seedlings used (number)	Tomato	191	1500.00	707.11
	Potato	209	6421.65	56483.03
Amount of money spent on seeds and seedlings for crops in the season (Birr)	Tomato	191	15599.59	46683.31
	Potato	209	7618.40	9268.62

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.3.6. Fertilizers input utilization for tomato and potato crops production

Farmers in the study areas have been responded that majority of them had used chemical fertilizers for their tomato and potato vegetables production in the last cropping seasons. Thus, 190(99.48%) and 202(96.65%) of farmers have used chemical fertilizer for tomato and potato cultivation at Ziway-Dugda and Tiyo districts, respectively in the last cropping seasons (Table 14). Only very few households, 0.52% for tomato and 3.35% for potato (from 400 respondents) did not use chemical fertilizers in the last cropping years for their vegetables cultivation in the two districts, respectively (Table 14). This indicated that use of chemical fertilizers for vegetable crops productivity increment is an important input and are more accessible in their areas.

Also the type of chemical fertilizers used by farmers to improve their vegetable crops in the study areas had significantly varied across the studied districts/crops and types of chemical fertilizers utilized by the responded communities. Majority of the respondents have been used Urea fertilizer (77.37%) for their tomato crop production and NPS fertilizer (88.12%) for potato crop production; but few households have been used NPS (22.63%) for tomato and Urea (11.88%) for potato production (Table 14). Though, the data indicated that both types of chemical fertilizers utilization possibility and importance for their vegetable crops production.

Time of Urea fertilizer application by farmers to improve their vegetables production and nutrients utilization by their crops in the study areas had significantly varied across the studied crops and households responded. Half Urea at planting and half Urea at vegetative growth stage were applied to tomato crop by 44.21% farmers and to potato crop by 25% farmers. Half Urea after establishment and the remaining half Urea at vegetative growth stage were applied to tomato crop by 28.42% farmers and to potato crop by 58.33% farmers (Table 14). About 8.95% and 12.5% respondent farmers had applied all the Urea at the time of planting; also 1.05% and 4.17% farmers had applied all the Urea after establishment of tomato and potato crops, respectively (Table 14). Also, 16.32% farmers had applied all the Urea fertilizer at vegetative growth stage of tomato and 1.05% farmers had applied Urea when land was highly moisturized/ after two weeks of planting/ after three weeks of planting of tomato; but farmers did not apply Urea fertilizers at these times for their potato crop production (Table 14). These indicated that there were various times of Urea application through splitting into different amounts for efficient utilization of nutrients by vegetables and to minimize losses of fertilizer.

Also time of NPS fertilizer application by farmers to improve their vegetables productivity and nutrients utilization by their crops in the study areas had significantly varied across the studied crops and households responded. Half NPS at planting and half NPS at vegetative growth stage was applied to tomato crop by 14.14% farmers and to potato crop by 14.05% farmers, and half NPS after establishment and the remaining half NPS at vegetative growth stage was applied to tomato crop by 13.09% farmers and to potato crop by 7.3% farmers (Table 14). Majority farmers (60.73% and 78.65%) had applied all the NPS fertilizer at the time of planting of tomato and potato crops, respectively. Few farmers (7.33%, 2.09% and 2.62%) had applied all the NPS after establishment, at vegetative growth stage, and not applied NPS to tomato crop, respectively; but farmers did not apply NPS fertilizer at these times for their potato crop production (Table 14). These indicated that even though there were various times of NPS application, large amount of NPS was applied at the time of planting of crops which indicates minimum losses of NPS fertilizer through leaching as compared to Urea fertilizer.

Farmers in the study areas have been responded that majority of them did not use organic fertilizers (manures, compost, vermicompost, ashes, plant residues) for their tomato and potato vegetables production in the last cropping seasons. Only 34(17.80%) and 86(41.15%) farmers have used organic fertilizers for tomato and potato cultivation at Ziway-Dugda and Tiyo districts, respectively in the last cropping seasons (Table 14). However, more households in the two districts, 157(82.20%) and 123(58.85%) did not apply organic fertilizers to tomato and potato cultivation in the last cropping years, respectively (Table 14). This indicated that majority of farmers in the districts had no organic fertilizers access or lacks awareness in organic fertilizers uses for better vegetables and soil productivity.

Table 14: Types of fertilizers utilized and time of application to tomato and potato crops production by farmers in the last cropping seasons (Frequencies)

Input	Response	Tomato		Potato	
		N	%	N	%
Chemical fertilizers applied for crop production	Yes	190	99.48	202	96.65
	No	1	0.52	7	3.35
Type of chemical fertilizer applied	NPS	43	22.63	178	88.12
	UREA	147	77.37	24	11.88
Time of Urea fertilizer applied for the crops	Half at planting and half at vegetative stage	84	44.21	6	25.00
	Half after establishment and the remaining at vegetative stage	54	28.42	14	58.33
	All at the time of planting	17	8.95	3	12.50
	All after establishment	2	1.05	1	4.17
	All at vegetative stage	31	16.32	0	0
	Others (when land is highly moisturized, after 2 weeks of planting, after three weeks of planting)	2	1.05	0	0
Time of NPS fertilizer applied for the crops	Half at planting and half at vegetative stage	27	14.14	25	14.05
	Half after establishment and the remaining at vegetative stage	25	13.09	13	7.30
	All at the time of planting	116	60.73	140	78.65
	All at vegetative stage	14	7.33	0	0
	All after establishment	4	2.09	0	0
	Other (NPS not used, used mulch, two weeks after planting)	5	2.62	0	0
Organic fertilizers applied: (compost, manure, ashes)	Yes	34	17.80	86	41.15
	No	157	82.20	123	58.85

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

The amounts of both organic and chemical fertilizers input used by farmers were showed variations across the crops and fertilizer types; Urea, NPS and Organic uses were ranged from 0.5 to 4400 kg, 0 to 8400 kg and 0 to 4500 Quintals with mean values of 374.47 kg, 598.16 kg and 227.44 Quintals for tomato crop in Ziway-Dugda district; and from 25 to 500 kg, 1 to 2000 kg and 0 to 1500 Quintals with mean values of 112.50 kg, 145 kg and 116.71 Quintals for potato crop in Tiyo district, respectively (Tables 15). The maximum and mean rates of Urea, NPS and organic fertilizers usage by farmers were more in tomato cultivation as compared to potato crop; this might be due to more amount of fertilizers required by the crop and low soil fertility of the district (Ziway-Dugda) in which tomato were produced and thus, additional use of organic fertilizer was crucial in order to minimize the usage of inorganic fertilizers (Table 15).

Also, Wubet *et al*. (2022) reported that sample farmers in the study area used similar average amount of inorganic fertilizer (130 kg ha^{-1}) for potato production at Farta district of Amhara region. However, Egata *et al*. (2021) reported that application of 300 kg ha^{-1} NPSB + 150 kg ha^{-1} urea to the Belete potato variety and 150 kg ha^{-1} NPSB + 250 kg ha^{-1} urea to Gudenie potato variety produced higher yield and better economic return in Holetta and areas with similar soil type and agro-ecologies by irrigation. Also Melkamu and Minwyelet (2018) reported that on soils with low phosphorous content, production of *Belete* and *Gudene* varieties with application of 283.75 and 181.60 kg ha^{-1} NPS rates, respectively are recommended; while, on soils with high phosphorous content production of local and *Gudene* varieties supplied with 136.20 and 181.60 kg ha^{-1} NPS, respectively, are recommended for higher profitability of potato production at Koga Irrigation Scheme. Feyissa (2018) reported that application of 200 kg ha^{-1} NPS, 300 kg ha^{-1} urea and 400 L ha^{-1} eco-green had produced better tomato productivity; Geletaw (2019) reported that application of 240 kg ha^{-1} NPS was optimum for effective vegetative performance of tomato, and Tsedu (2019) suggested to grow ARP tomato d2 variety with the application of 250 kg ha^{-1} NPSBZn fertilizer and Cochoro variety with 300 kg ha^{-1} NPSBZn in the study area considering the highest volume of fruit yield produced, net benefit and acceptable MRR. Farmers in Ziway-Dugda and Tiyo districts had used low amounts of NPS and Urea fertilizers for potato production as compared to the previous studies mentioned above which indicated application of fertilizers without recommendation that might reduced productivity.

The costs incurred by farmers on both organic and chemical fertilizers inputs were also showed variations across the crops and fertilizer types; costs of Urea, NPS and organic fertilizers were ranged from 58 to 114,400 Birr, 24 to 583,560 Birr and 0 to 15,000 Birr with mean costs of 9,529 Birr, 18,875 Birr and 1,356 Birr for tomato crop, and from 400 to 10,000 Birr, 50 to 48,000 Birr and 0 to 15,000 Birr with mean costs of 2,392 Birr, 3,291 Birr and 887 Birr for potato crop in the studied districts, respectively in the season (Tables 15). The average costs of Urea, NPS and organic fertilizers usage by the farmers for tomato cultivation were higher as compared to potato cultivation; this might be due to the more amount of fertilizers were applied by farmers in low land area (Ziway-Dugda district) where low soil fertility was available for tomato cultivation. But the costs of organic fertilizer was lower than that of chemical fertilizers applied; thus, additional use of organic fertilizer is crucial in order to minimize the costs of inorganic fertilizers and improve the soil productivities for crops cultivation (Table 15).

Table 15: Amount and costs of fertilizers used for tomato and potato crops cultivation (Descriptive Statistics)

Type, amount & costs of fertilizer	Crop	N	Minimum	Maximum	Mean	Std. Deviation
• Urea amount used for the crop (kg)	• Tomato	166	0.5	4400	374.47	623.02
	• Potato	24	25	500	112.50	104.78
• Amount/costs of Urea (Birr)	• Tomato	166	58	114400	9529.84	17286.84
	• Potato	24	400	10000	2392.46	2133.56
• NPS amount used for the crop (kg)	• Tomato	166	0	8400	598.16	1235.46
	• Potato	178	1	2000	144.99	220.24
• Amount/cost of NPS (Birr)	• Tomato	180	24	583560	18875.84	65189.28
	• Potato	178	50	48000	3291.41	5417.71
• Organic fertilizers (compost, manure, ashes) used (Quintal)	• Tomato	32	0	4500	227.44	821.20
	• Potato	86	0	1500	116.71	294.97
• Amount/costs (Birr) (the total cost of organic fertilizer used for the crop in the last cropping season)	• Tomato	34	0	15000	1356.76	2966.71
	• Potato	86	0	15000	887.76	2281.40

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.4. Types of Services and their Sources for Vegetables Production

3.4.1. Extension advices given to farmers for vegetables cultivation in the study areas

The extension advisory services offered for tomato and potato production were varied across various activities of vegetable farms. More importantly, the study results indicated 52%, 79.25%, 22%, 52.75%, 60.25%, 32.75%, 32.75% and 11.25% of the respondents were accessed the extension advisory services on seed preparation, fertilizers/compost applications, transplanting, protection, harvesting, post-harvesting handling, marketing and others, respectively. But 48%, 20.75%, 78%, 47.25%, 39.75%, 67.25%, 67.25% and 88.75% of them did not access extension advisory services on vegetable crops that were organized by districts and other officers, respectively (Table 16). Regarding to advisory of extension services access, among the total sampled respondents, majority of them responded that as they have been accessed the above mentioned advisory services and also some of them have access of two or more advisory services in same cropping seasons. This large number of the respondents in accessing advisory extension services might be due to availability of production and experts around the community which enhances their timely communication with scholars. However, majority of them (57.25%) did not have access to extension contact in relation to tomato and potato crops production except some farmers (42.75%) in the cropping year of 2021 in the study areas (Table 16). This indicated that majority of them need to have extension services, but not accessible from year to year as needed. According to the survey result of Wubet *et al*. (2022), 94.31% of the sample households benefited from extension service and frequency of extension contact was statistically significant.

Table 16: Extension advices given to potato and tomato producers at Tiyo & Ziway-Dugda districts

		Yes		No		Total	
		Numb	%	Numb	%	Numb	%
Extension advices given specifically on tomato & potato production	Seed bed preparation	208	52.0	192	48.0	400	100
	Fertilizer (compost) applications	317	79.25	83	20.75	400	100
	Transplanting	88	22.0	312	78.0	400	100
	Protection	211	52.75	189	47.25	400	100
	Harvesting	241	60.25	159	39.75	400	100
	Post-harvest handling	131	32.75	269	67.25	400	100
	Marketing	131	32.75	269	67.25	400	100
	Others	45	11.25	355	88.75	400	100
Having extension contact in relation to tomato & potato production in the year 2020/21 cropping season		171	42.75	229	57.25	400	100

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.4.2. Training access and farmers participation on it for vegetables cultivation

Training is the most important service in agriculture sector for various actors, specifically for vegetables producers which is used to address the problems of skills and knowledge related to production and management practices ranging from land and inputs preparation to production to marketing of their produces. The study showed that from the total respondents in the two districts, 227(56.75%) had participated to various training; but 173(43.25%) of them did not participate in any of training (Table 17). The training was given to farmers on various production and management practices of vegetables in the last cropping seasons in the study areas. The training was delivered to farmers on varieties (150), tillage systems (110), land conservation (73), compost preparation and uses (140), dairy (89), crop rotation (113), fertilizers (152), herbicides (122), fungicides (127), diseases management (129), safety (44), harvesting produces (64), storage of harvested produces (30), cleaning (14), protection (97) and on rotation based farm demonstration (26) (Table 17). There was participation of farmers on two or more of the above mentioned areas of agriculture activities; but other farmers did not get training on the above mentioned one or more of the production and management practices, respectively.

Table 17: Farmers participation and areas of training given on tomato and potato cultivation

Items/Responses		Yes		No		Total	
		Num	%	Num	%	Num	%
Participation in training		227	56.75	173	43.25	400	100
Kind/areas of training given to producers on vegetables	Varieties	150	37.5	250	62.5	400	100
	Tillage	110	27.5	290	72.5	400	100
	Conservation	73	18.25	327	81.75	400	100
	Compost	140	35.0	260	65.0	400	100
	Dairy	89	22.25	311	77.75	400	100
	Crop rotation	113	28.25	287	71.75	400	100
	Fertilizer	152	38.0	248	62.0	400	100
	Herbicide	122	30.5	278	69.5	400	100
	Fungicide	127	31.75	273	68.25	400	100
	Diseases	129	32.25	271	67.75	400	100
	Safety	44	11.0	356	89.0	400	100
	Harvesting	64	16.0	336	84.0	400	100
	Storage	30	7.5	370	92.5	400	100
	Cleaning	14	3.5	386	96.5	400	100
	Protection	97	24.25	303	75.75	400	100
	Rotation based on farm demonstration	26	6.5	374	93.5	400	100

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

The delivery modes of the training to farmers also plays critical roles in improving their practical skills and experiences; thus, respondents in the study areas were replied that the mode of the training was more theoretical/class room (27%), both theory and practical (17%) and practical or demonstration (12%) on vegetables production (Table 18). The quality of the training was also rated by farmers as 8(2%) very dissatisfying, 39(9.75%) dissatisfying, 91(22.75%) satisfying and 87(21.75% very satisfying and others did not rate the quality of the training on each criteria (Table 18). Farmers responded that they had reasons for the training was not very satisfying like level of training was not enough (16.75%), mostly theoretical and has limited practical and demonstration (16.25%), trained contents cannot be implemented (12%) and low quality of training (6%) were the major reasons raised by farmers participated on the training in the last cropping seasons (Table 18). Others were not participated on the training and not reasoned out the quality of the training. These all indicates that practical and demonstration based training is required by farmers to improve their skills and knowledge of cultivation and management of vegetables farms.

Farmers in the study areas had also raised that they want to participate frequently on various kinds of training of agricultural activities but not available. Those various kinds of training farmers would like to participate in more frequently but not available as they need are about varieties (295), tillage systems (225), land conservation (180), compost preparation and uses (252), dairy (225), crop rotation (223), fertilizers (290), herbicides (271), fungicides (297), diseases management (289), safety (205), harvesting produces (268), storage of harvested produces (230), cleaning (167), protection (259) and on rotation based cultivation through farm demonstration (150) (Table 18). These indicated that there is high demand within the farmers for developing their skills and knowledge through training and demonstrations of practical learning for better production of their vegetables. Also majority of farmers (87%) need to train on agricultural activities without receiving extra payment; only 13% of the study areas farmers denied to train without extra payment in the two districts (Table 18). This indicated that majority of vegetables producers need to advance their skills and knowledge from experts without seeking payments from external body.

Table 18: Training mode, quality and interest areas of farmers for the training on vegetables cultivation

Variables	Items/Responses	Yes		No		Total	
		N	%	N	%	N	%
Mode of training delivery	Theory/class room	108	27.0	292	73.0	400	100
	Both theory & practical	68	17.0	332	83.0	400	100

	Practical/demonstration	48	12.0	352	88.0	400	100
Quality level of the training	Very dissatisfying	8	2.0	392	98.0	400	100
	Dissatisfying	39	9.75	361	90.25	400	100
	Satisfying	91	22.75	309	77.25	400	100
	Very satisfying	87	21.75	313	78.25	400	100
Reason for the training not very satisfying	Not enough amount of training available	67	16.75	333	83.25	400	100
	Mostly theoretical & limited practical training	65	16.25	335	83.75	400	100
	Trained content cannot be implemented	48	12.0	352	88.0	400	100
	Low quality of training	23	5.75	377	94.25	400	100
	Other	1	0.25	399	99.75	400	100
Kinds of training farmers want to participate in more frequently but is not available	Varieties	295	73.75	105	26.25	400	100
	Tillage	225	56.25	175	43.75	400	100
	Conservation	180	45.0	220	55.0	400	100
	Compost	252	63.0	148	37.0	400	100
	Dairy	225	56.25	175	43.75	400	100
	Crop rotation	223	55.75	177	44.25	400	100
	Fertilizer	290	72.5	110	27.5	400	100
	Herbicide	271	67.75	129	32.25	400	100
	Fungicide	297	74.25	103	25.75	400	100
	Diseases	289	72.25	111	27.75	400	100
	Safety	205	51.25	195	48.75	400	100
	Harvesting	268	67.0	132	33.0	400	100
	Storage	230	57.5	170	42.5	400	100
	Cleaning	167	41.75	233	58.25	400	100
	Protection	259	64.75	141	35.25	400	100
	Rotation based on farm demonstration	150	37.5	250	62.5	400	100
Farmers need to participate in the agricultural trainings without receiving extra payment	348	87.0	52	13.0	400	100	

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

3.4.3. Skills needed by farmers for vegetables cultivation in the study areas

In both study areas, skills needed for tomato and potato vegetables production and management have been identified as potential services for better productivity and livelihoods of farmers. Majority of farmers in the study areas were responded that they need skills improvement on seedling/planting material preparation as very important (51.31% and 33.01%) and important (27.23% and 29.66%); although other farmers responded that the levels of skills demanded by them as neutral (12.56% and 21.05%), slightly important (5.76% and 13.40%) and not important (3.14% and 2.87%) for tomato and potato cultivation, respectively (Table 19). Similarly, farmers demanded skills improvement on weeds control methods in consequence of very important (34.56% and 21.53%), important (28.27% and 33.97%), neutral (26.18% and 29.19%), slightly important (10.47% and 12.44%) and not important (0.52% and 2.87%) for tomato and potato vegetables, respectively (Table 19). This indicated that majority of farmers are requiring skills on controlling methods of weeds from vegetables farms for better productivities. Only few farmers has responded that no interest of skills improvement on planting materials preparation and weeds control methods on both crops which might be due to lack of interest in training (Table 19).

Management of diseases in vegetables firms using various techniques are important to produce better yields and qualities of tomato fruits and potato tubers. Vegetables losses due to diseases both on farms and after harvested are significant which needs critical control and management practices by producers. The level of importance of skills needed on diseases management was also varied significantly by vegetables producers in the study areas. The level of skills demanded to manage diseases in vegetables production by farmers was very important (72.78% and 55.03%), important (17.80% and 27.27%), neutral (9.42% and 12.92%), slightly important (0% and 2.87%) and not important (0 % and 1.91%) for tomato and potato vegetables, respectively (Table 19). This indicated that majority of farmers are requiring skills of controlling methods of diseases for better productivities of their vegetables. Only few farmers had no interest of skills improvement to manage potato diseases which might be due to small scale land operation of potato and less diseases occurrence in their farms (Table 19).

Management of vegetable farms after establishment is also a crucial in farm businesses to be productive in their firms. Farmers have responded differently in the level of importance of skills needed in field management after plantation of tomato and potato crops. Thus, the level of importance of skills needed by farmers on fields management after plantation of tomato and potato crops was very important (41.37% and 32.06%), important (31.41% and 30.14%), neutral (18.32% and 28.23%), slightly important (7.33% and 7.66%) and not important (1.57% and 1.91%), respectively (Table 19). This indicated that majority of farmers are requiring skills of managing their vegetables fields after established. Only few farmers had no interest on skills improvement of their fields' management after establishment of their crops which might be due to having less awareness on the importance of managing vegetables farms (Table 19).

Postharvest handling and management of vegetable produces is also very important to maintain quality and extend produces shelf-life. The responses of farmers have been varied significantly to the level of importance of skills needed for postharvest treatment and storage of tomato and potato produces in Ziway-Dugda and Tiyo districts, respectively. Thus, the level of importance of skills needed by farmers on postharvest treatment and storage after tomato fruits and potato tubers harvested was very important (43.45% and 37.32%), important (28.80% and 32.06%), neutral (21.99% and 22.49%), slightly important (4.19% and 5.74%) and not important (1.57% and 2.39%), respectively (Table 19). This indicated that majority farmers have been requiring skills on postharvest treatment and storage for their vegetables produces' qualities maintaining and shelf-life extension after harvested. Only few farmers have no interest on skills needed for postharvest management and storage after their crops became harvested which might be due to having less awareness on the postharvest handling and management importance.

Having market access and selling vegetables produces on time at optimum prices are very important especially for perishable commodities to minimize losses and role of middlemen across the vegetables market chain. The responses of farmers have been also varied significantly to the level of importance of skills needed for marketing of tomato and potato produces in Ziway-Dugda and Tiyo districts, respectively. Thus, the level of importance of skills needed by farmers on marketing of tomato fruits and potato tubers was very important (36.65% and 35.89%), important (23.56% and 26.32%), neutral (27.75% and 22.49%), slightly important (9.42% and 11%) and not important (2.62% and 4.30%), respectively (Table 19). This indicated that majority of farmers are requiring skills on marketing systems of their vegetables produces to have more income and improve their livelihoods. Only few farmers have responded as no interest on skills of marketing their products which might be due they are producing in small amounts and using them for house consumption, selling local markets and for seeds proposes (Table 19).

Table 19: Skills needed by farmers for tomato and potato vegetables production and management

S.No	Skills needed on	Level of importance	Tomato		Potato	
			N	%	N	%
1	Seedling/planting material preparation	Very important	98	51.31	69	33.01
		Important	52	27.23	62	29.66
		Neutral	24	12.56	44	21.05
		Slightly important	11	5.76	28	13.40
		Not important	6	3.14	6	2.87
2	Weed control method	Very important	66	34.56	45	21.53
		Important	54	28.27	71	33.97
		Neutral	50	26.18	61	29.19

		Slightly important	20	10.47	26	12.44
		Not important	1	0.52	6	2.87
3	Disease management	Very important	139	72.78	115	55.03
		Important	34	17.80	57	27.27
		Neutral	18	9.42	27	12.92
		Slightly important	0	0	6	2.87
		Not important	0	0	4	1.91
4	Field management after plantation	Very important	79	41.37	67	32.06
		Important	60	31.41	63	30.14
		Neutral	35	18.32	59	28.23
		Slightly important	14	7.33	16	7.66
		Not important	3	1.57	4	1.91
5	Post-harvest treatments and storage	Very important	83	43.45	78	37.32
		Important	55	28.80	67	32.06
		Neutral	42	21.99	47	22.49
		Slightly important	8	4.19	12	5.74
		Not important	3	1.57	5	2.39
6	Marketing	Very important	70	36.65	75	35.89
		Important	45	23.56	55	26.32
		Neutral	53	27.75	47	22.49
		Slightly important	18	9.42	23	11.00
		Not important	5	2.62	9	4.30
		Total	191	100	209	100

Source: Data collected during 2022 by kobo software and analyzed using SPSS version 22

4. CONCLUSION

This baseline study gives an insight into the range of available potentials, resources and inputs for tomato fruits and potato tubers production in the two districts of Arsi Zone, Ethiopia during the last cropping seasons. The farmers in the study areas produced different types of crops in addition to tomato and potato vegetables with various production potentials. Many farmers in the study areas had potentials and inputs for production of tomato and potato crops like land access obtained in different ways; farming practices by changing crops, rotating, changing investment types, and other resources; livestock potentials; various inputs like machineries, seeds, fertilizers, irrigation schemes; and various services availability like skills, training and extension advices for vegetables production. Thus, it is possible to conclude that there were many production potentials, inputs and services used by farmers to produce better vegetables for both consumption and marketing to have improved livelihoods in the study areas even though some farmers are not within these ranges and need future capacitating.

5. Recommendations

This baseline survey is the first step towards having information to the development of vegetables farming systems, and farmers' productivity, income and livelihoods improvement conducive to the local community. Thus, the information gathered in this study will help to guide or improve future production and productivity of vegetable crops in the study areas and others like. However, there are various constraints identified like absence of resources, lands, livestock, inputs, services, and lack of production and absence of practice and demonstration based skills and knowledge on cultivation of vegetables which need interventions in future by different actors.

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