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Journal of Science and Sustainable Development (JSSD)

The International Journal of Ambo University

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Journal of Science and Sustainable Development (JSSD)

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- To promote the effective teaching of science, technology and management; identifying problems and developing solutions through dissemination of new information from researches align in the direction of solving the basic need of the country.

- To contribute to the pool of scientific information by providing (creating) more access for researchers to have their original scientific work relevant to the need of the country and the world at large.

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Following the abstract, about 3 to 5 **key words** that will provide indexing references should be listed.

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Tables should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, the captions. Each table should be numbered consecutively in Arabic numerals. Tables should be self-explanatory without reference to the text. The same data should not be presented in both table and graph forms or repeated in the text.

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Abayomi (2000), Agindotan et al. (2003), (Kelebeni, 1983), (Usman and Smith, 1992), (Chege, 1998; Chukwura, 1987a,b; Tijani, 1993,1995), (Kumasi et al., 2001)

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Moran GJ, Amii RN, Abrahamian FM, Talan DA (2005). Methicillinresistant *Staphylococcus aureus* in community-acquired skin infections. Emerg. Infect. Dis. 11: 928-930.

Chikere CB, Omoni VT and Chikere BO (2008). Distribution of potential nosocomial pathogens in a hospital environment. Afr. J. Biotechnol. 7: 3535-3539.

Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing *Escherichia coli* in the Calgary Health Region: emergence of CTX-M-15-producing isolates. Antimicrob. Agents Chemother. 51: 1281-1286.

Pelczar JR, Harley JP, Klein DA (1993). Microbiology: Concepts and Applications. McGraw-Hill Inc., New York, pp. 591-603.

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RESEARCH PAPER

Analysis of Vegetable Seed Supply Chain of Smallholder Farmers: The Case of Ada'a District, East Shewa Zone, Oromia National Regional State, Ethiopia

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Abstract

The vegetable sub-sector is one of the important sub-sectors of the Ethiopian economy. Consequently, the return from vegetables per unit area is several times higher than from major cereals. Hence, this research attempted to analyze factors affecting the vegetable seed supply chain system in Adea district, East Shoa zone, Oromia Region of Ethiopia, focusing on onion crop. A household survey with a pre-tested structured questionnaire and a key informant interview with checklists were used to collect primary data. The data was collected from 150 farmers and analyzed using STATA software. To address these objectives, multiple linear regression models were adopted. Ordinary Least Square (OLS) estimation shows that education level, sex of the household head, age of the household head, farm experience of the household, oxen ownership of the household head, area of vegetable and income of the vegetable significantly affect the vegetable seed supply chain system. The regression result indicated that the price of onion seed was negatively related to the quantity of onion seed used. Similar to the case of onions, the area allocated to tomatoes also had a positive impact on the quantity of tomato seed used by the sample households. However, unlike their significant impact on onions, both age and education had an insignificant impact on the quantity of tomato seeds used by the sample households. There is a special need to develop vegetable sector-specific guidelines for the development of the seed supply chain in Ethiopia. This calls for the transformation of the seed supply system from an informal to a more formal one through system establishment and capacity development..

Keywords: seed supply chain system analysis, vegetables, tomato, onion, multiple linear regression

Introduction

Ethiopia's agricultural sector is a powerhouse, contributing significantly to the country's economy. It makes up nearly half (46%) of the GDP, fuels most exports (80%), and employs a staggering 73% of the workforce. However, rain-fed subsistence farming remains the dominant practice, with smallholder farmers typically managing plots of less than a hectare (Aklilu, 2015). Vegetables offer an exciting opportunity for growth within agriculture. Compared to grains and other annual crops, they boast higher productivity and shorter growing seasons, allowing for multiple harvests per year (up to three). This labor-intensive sector also holds promise for job creation (Ayana *et. al*. 2014; Ketema and Tadesse *et al*., 2019).

Vegetable production is becoming an increasingly important activity in the agricultural sector of Ethiopia (CSA, 2015). The return from vegetables per unit area is several folds higher than major cereals. Vegetable production also plays a great role in reducing unemployment as it is labor-intensive and needs special skills (*A. cepavar. aggregatum*), carrot and beetroot (Aklilu, 2000; EHDA, 2011, 2012).

The most significant issues that vegetable crop production companies and traders face are a lack of sufficient improved varieties, a lack of quality planting materials and supply systems, a lack of appropriate production technology, biotic factors such as disease and insect pests, abiotic factors such as drought, and a lack of improved harvesting, post-harvest handling, and storage facilities (Ketema and Tadesse, 2019).

Ethiopia's onion production is much lower than other African countries and the world average. During the 2013/2014 cropping season, the total area under onion production was estimated to be 24, 375.7 hectares with an average yield of about 9.02 tons per hectare (Lemma and Shimelis, 2003). In comparison to the global average of 19.7 tons per hectare, this is an extremely low output (Weldemariam, et al, 2015). Onions are a nutritious, versatile, and economical agricultural product with a long shelf life, making them suitable for various regions and reducing food west. They are affordable to grow, creating jobs in farming, transportation, and storage. Onions can be grown responsibly using practices like crop rotation and integrated pest management, contributing to the agricultural landscape and protecting the environment (Bassim and Hayat, 2022). Because onion is the most grown species in the East Shoa zone Adea district, where the research was conducted, the focus of this study is on it.

In Ethiopia, the seed industry is still in its infancy. One of the key reasons for the correct growth of the seed industry is a lack of seed production technology. It is challenging for public universities and research organizations to multiply and distribute high-quality seeds on their own. The seed industry, particularly in the private sector, has the potential to be improved and developed. Currently, Ethiopian Seed Enterprise is projected to play a larger role in reducing seed shortages in the medium future, if not immediately (Fasikaw, 2019).

Horticulture is one of the main research programs in the Ethiopian Agricultural Research System. The horticulture research program, with a focus on tomato, pepper, onion, snap bean, has been coordinated by the Melkasa Agricultural Research Center. Regional research centers focus more on root and tuber crops such as potato, sweet potato, enset, taro, yam, and cassava (ISSD, 2013; MoA, 2012; Emana *et al*., 2014). Ethiopia's (vegetables) seed marketing remains one of the weakest links in the seed supply chain. Remote area farmers or those furthest from cities are faced with the inaccessibility of seed market information and infrastructure. In this respect development and promotion of different seed systems is a potential solution to this problem (Fasikaw, 2019; Emana *et al*, 2014; Getachew, 2010).

The imported seeds are distributed by local traders, farmers' cooperatives/unions, bureaus of agriculture, and NGOs. Such seeds are rarely checked for quarantine and quality by the seed regulatory department of the Ministry of Agriculture and the regional bureaus of agriculture. Access to quality seed sources is limited in case farmers use any available seeds they access which increases seed-borne diseases and subsequent seed damage (Fasikaw, 2019).

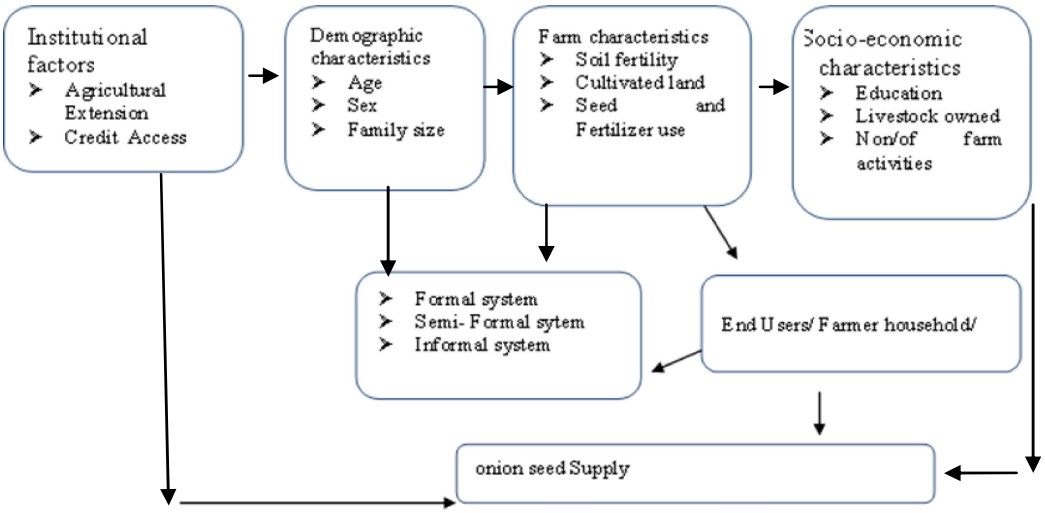
Most farmers and even some extension agents do not know the types of imported varieties used by the farmers. The varietal replacement period is very long as older varieties are still in production due to the weak variety development program and slow promotion of newly released varieties by the extension system. Whenever there is chance varieties are chosen or replaced for their yielding potential, taste, color, long shelf life, market demand and largely availability of seed Emana et al., 2014). Ethiopia's informal seed system has mostly gone unacknowledged, unappreciated, and unreported. Farmers' requirements have not been met by the formal seed sector (Fasikaw, 2019; Getachew, 2010). According to Emana et al., (2014), the overall vegetable seed system of a country is in the infant stage.

Ethiopia's seed industry faces a number of hurdles. The country lacks the expertise and infrastructure to run efficient seed businesses,

and there's a constant threat of new diseases and pests due to weak border controls. Furthermore, a clear national seed strategy is absent, and current extension services aren't providing adequate support to farmers. Limited collaboration within the seed sector, private companies focusing on profitable crops, and a general lack of knowledge and resources are further roadblocks. These challenges all contribute to an inadequate seed system in Ethiopia. As a result, this work aims to fill a research gap and contribute to the development of evidence for policymakers about the onion seed supply chain system and its problem analysis in Adea district of East Shewa zone, Oromia regional state.

Conceptual Framework

Ethiopia's seed system has undergone a tremendous change during the past three decades. But, still, the sector is unable to guarantee farmers' access to seeds of improved varieties. This is mainly because of the highly centralized seed distribution system and the absence of seed marketing. Based on the literature research, it is expected that onion seed supply is influenced by a variety of factors presented in Figure 1.



Materials and methods

Adea district was located in Oromia Regional State, East Shoa Zone, with the capital located 47 km Southeast of Addis Ababa. Most of the land (90%) is plain highland ranging between 1540 to 3100 meters above sea level. The district has a total of 26 kebeles of which 22 are rural-based kebeles administration areas and 4 are town kebeles. The total human population of the district is estimated by CSA is 131,162. The district has two agroecologies which are Dega and Weina Dega. Black clay and vertisol are the dominant soil types, with good soil fertility but with water logging problems The total land of the district is estimated to be 96,680 ha, Bishoftu Town and surrounding cover 19,543 ha and 77,137 ha is covered by rural areas, out of which 61,709 (80 %), ha is cultivated land, 2,603 (3.4%) ha is grazing land, 6,011 (7.8 %), ha is forest and 6,814 (8.8 %) ha is covered with others. Black clay and vertisol are the dominant soil types, with good soil fertility but water logging problems in those areas where the land slope is below 8%. Household average farm size varies from 1 to 2.5 ha and the major farm operation is done by oxen power. The farming system is a mixed crop-livestock production system. Major crops grown are teff, wheat (mainly bread variety), vegetable crops (mainly Onion, Tomato, kale, cabbage, etc.) and pulses. Chickpea is the main

pulse crop grown in the district and used as a crop rotation to wheat and teff crops. Irrigated horticultural crops are the most emerging business in areas where small-scale irrigation has been identified as a potential venture. Livestock farming under smallholder management consists of cattle/oxen, poultry and small ruminants. Apiculture is emerging in some pocket areas like Yerer Mountain (ADAO, 2020).

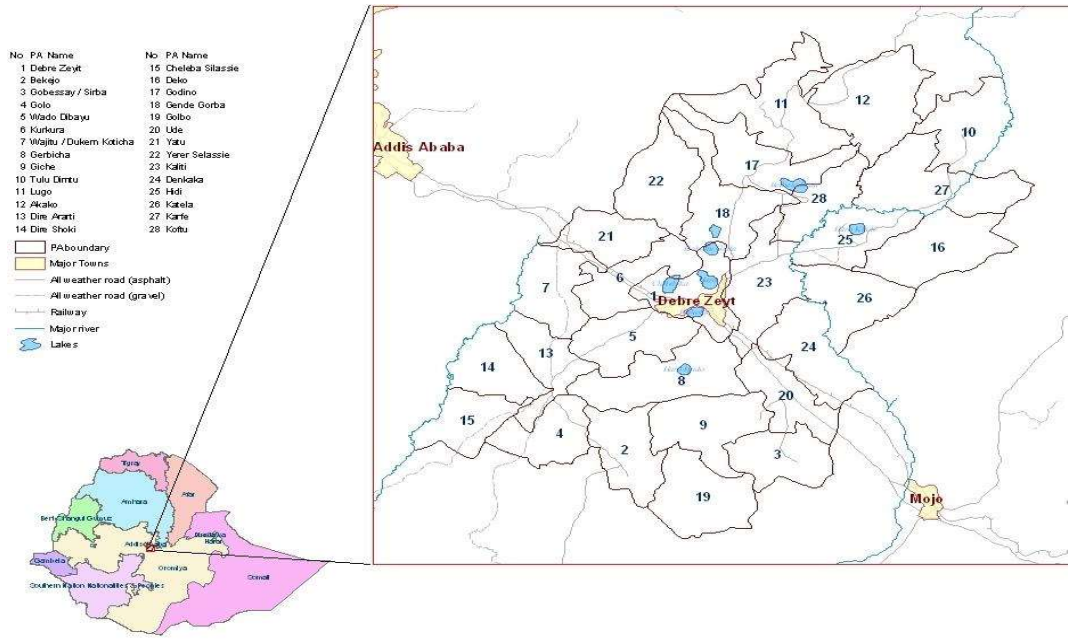


Figure 1 Map of Adea District (Study area)

Source: Adea District Agriculture and Natural Resource Office

Data Types and Sources

Primary and secondary data were used in the analysis of the vegetable seed supply chain. The primary data were collected through face-to-face interviews using a standardized and pre-tested questionnaire, which was filled out by trained enumerators working under tight supervision. Four Agricultural Office development agents and one district expert of seed supply and utilization analyzer gathered data.

Method of Data Collection

The primary data from onion producers was collected using a structured questionnaire that was pre-tested before the actual survey. Along with the formal survey, rapid appraisal using group discussion, key informant discussions and direct observation were undertaken along the vegetable seed supply chain system. The primary data was supplemented with secondary data.

Sampling Technique and Sample Size Determination

In this study, a two-stage sampling method was used. First, out of 26 kebeles in the district four potential vegetable-producing kebeles; namely, Denkeka, Hidi, Godino and Ouda were randomly selected. In the second stage, 150 farm households were selected randomly from those kebeles who are producing vegetables (Onion) taking into account probability proportional to the size of onion producers in each sample kebeles.

The study used a sample determination formula developed by Yemane (1967) presented as equation 1.

n=N/(1+N(e)2)…….....(1)

Where n is the sample size, N is the total target population of the area or households and e is the level of precession (sampling error). In this study, using an e value of 8 % and 4100 total population of vegetable-producing households, the sample size of 150 was obtained as follows:-

n=4100/(1+4100(〖0.08)〗 ^2)= 150. …… (2)

In general, using the above formula sample size of 150 vegetable producers (Onion and Tomato) was selected from four kebeles (Table 1).

Table 1. Sample distributions of vegetable (Onion) producers in selected kebeles

No.	**Name** of Kebele's	Total number of Vegetable producers	Number of sampled households
1	Denkeka	1367	50
2	Hidi	1093	40
3	Godino	957	35
4	Udea	683	25
Total		4100	150

Source: Adea District Agriculture and Natural Resource Office

Methods of Data Analysis

Descriptive statistics such as mean, minimum, maximum, percentages, frequencies and standard deviation were applied to describe the demographic, socio-economic, farm and institutional characteristics, supply and distribution of onion seed for producers in the study area. The econometric model was also used depending on the objective of the study and the nature of the data at hand. In this study, the dependent variable is the quantity of seed used by the sample household. Among the vegetables produced, onion is commonly produced in the study area.

When the dependent variable is just a continuous variable, Greene (2003) specifies the multiple regression analysis as Y= f(price, onion seed supplied(used), access to extension service, education level, access to market information, experience in vegetable production, sex of household head, access to credit, age, and so on...). The supply function econometric model specification in matrix notation is estimated by:

Yi= β0 + βiXi + Ui …… (3)

Where:

Yi = amount of Vegetable supplied (used) by Household
β0 = the constant/intercept
βi = a vector of the estimated coefficient of the explanatory variables
Xi = a vector of explanatory variables
Ui = Error term

Following Green (2003), the multiple linear regression models are specified as;

Yi=F(X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14)

Where

Yi= quantity of vegetable seed Supplied (used) by household
X1= Lagged Market Price
X2= Frequency of Agricultural Extension Contact
X3= Farm Land allocated
X4= Number of Oxen owned
X5= Age of household head
X6= Education of household head
X7= Access to Credit
X8= Adoption of seed
X9= Gender
X10= Income from Off Farm job
X11= Access to market information
X12 = Family size
X13 = Membership of Primary Cooperatives
X14 = Distance from the nearest market

Results and discussions

Descriptive Result

Important household background variables are sex, age and education of the household head and family size. Detailed information on these variables is presented in this sub-section. Gender was analyzed by checking the numbers of male and female-headed households (Table 2). The sample population of farmer respondents considered during the survey was 150. As shown in Table 4, out of the total households headed by interviewers, 133 (88.7%) were male-headed households, while 17 (11.3%) were female-headed households.

Table 2. Sex of Household head characteristics

Variables	Indicators	Frequency	Percent (%)
Sex of HH	Female	17	11.3
	Male	133	88.7
Total		150	100

Source: Survey result

The level of education of the household head, a primary decision maker, is an important variable for vegetable production. The result indicated that only 0.67% of the sampled vegetable producers were illiterate, and from grade one up to eight (1–8) 49.33%, from high school (9–12 grades) 44.67%, and above 12 grade/diploma holder was 5.33% (Table 5). On average vegetable producers in the study area are grade eight complete. This finding shows the proportion of literate household heads for the current study is higher than previous reports by Demis (2014) in Bora district of the same zone, who found only 55%, and the same district (Adea) reported by Teshome (2009), who found 65% of the household heads were educated. The proportion of uneducated household heads in the current study is also lower than the proportion of uneducated seed-producing households in the SNNP region reported by Walelign (2008), who found 20%, 10%, 23%, and 30% levels of illiteracy in Angacha, Dale, Chencha, and Hula districts, respectively. This suggests that access to formal education is improving over time, which is an opportunity to better understand vegetable production practices and hence increase productivity (Table 3).

Table 3. Education level of household head

Variable	Frequency	Percent
Education level of household headed		
Uneducated	1	0.67
Grade 1-8	74	49.33
Grade 9-12	67	44.67
Above 12	8	5.33
Total	150	100

Source: Survey result, 2021

The number of family members in rural households is an important input for agricultural labor. The study result indicated that the average family size of the sample household was 4 persons (Table 4). The table also shows that the mean number of extension

contacts of the respondents in the study area is 12.06. Extension service providers included experts working for agriculture departments, DAs, and forward-thinking farmers. The services provided were about vegetable production, input supply and use systems, seedling raising, harvesting, and post-harvest handling. Experience in vegetable farming is important to learn from experience about vegetable production practices. As shown in Table 4, the mean farm experience of the respondents in the study area is 4.77.

Oxen are an important asset for rural households for several purposes. They are sources of draught power for plowing. They are also used for threshing, a means of storing assets and an indication of wealth in a rural setting. The study result indicated that the majority of the sample households owned a pair of oxen, which is important for ploughing land. The mean number of oxen ownership of the respondents in the study area is 2.27 (Table 4).

Land is one of the key inputs for agricultural production in general and vegetable production in particular. The result indicated that the mean land holding of the sample vegetable producers was 2.12 hectares, with a standard deviation of 0.41 hectares. The minimum and maximum land holdings were 0.25 hectares and 5 hectares, respectively (Table 4).

Table 4. Descriptive statistics of continuous variables

Variables	Mean	Std. Dev.	Min	Max
Age of HH	38.58	9.76	22	61
Education HH	8.24	2.89	0	13
Extension Contact	12.06	5.69	0	44
Land size of HH	2.12	0.41	0.25	5
Oxen Ownership of HH	2.27	0.67	2	4
Family size of HH	4	1.37	2	7
Farm experience of HH	4.77	2.28	1	12
Seed price	49512.5	33510.92	8750	160,250

Source: Own survey Result 2021

Access to institutional service of farm households

Starting from land preparation up to the marketing of the product, finance is among the crucial elements assisting the activities. As indicated in Table 5, only 21.33% of sampled producers had access to credit while 78.67% of them had no access during the survey period. The main purpose farmers needed credit was to purchase fertilizer, seeds for vegetables, chemicals, and other agricultural inputs. The reason behind the limited access to credit for farmers was that the majority of farmers cover the cost of production of vegetables by selling grain produced by rainfall and lack of collateral. Although credit was accessible and available for poor farmers to build assets and secure food by purchasing the different packages designed by the regional government for grain producers, there was a lack of attention to access and avail credit for vegetable producers.

Households in the study area practiced handcraft, renting assets, petty trade, selling of local drinks, and salary. In the sampled

households, about 35.33% were engaged in off-farm income activities (Table 5).

A look at access to market information shows that there is no system in place for systematically collecting, analyzing, and disseminating information relevant to the needs of different actors. However, almost all (89.33%) of the sampled farmers had access to market information from different sources, and only 10.67% had no such access (Table 5). Analysis revealed that the major sources of market information were traders/agro-dealers, brokers, radio/television, friends/relatives, district and kebele experts, and combinations of them.

Table 5. Descriptive statistics of dummy variables

Variables	Category	Frequency	Percent
Off-farm Income of HH	No =0	97	64.67
	Yes = 1	53	35.33
Access to credit	No = 0	118	78.67
	Yes =1	32	21.33
Access to market information	No = 0	16	10.67
	Yes =1	134	89.33
Total		150	100

Source: Own survey result, 2021.

Vegetables seed supply chain system

Table 6 shows the sources of vegetable seed for the sampled household. The majority (86.66%) of the sampled household purchased vegetable seed from informal sources, whereas 10.67% purchased from formal sources, and about 2.67% did so from semi-formal sources. Given that the majority of the sampled households obtained seed from informal sources, the quality of the seed is questionable, which, in turn, would affect vegetable production and productivity (Table 6).

Table 6. Vegetables seed supply chain system for the sample household

Seed source type	Frequency	Percent
Informal	130	86.66
Semi-formal	4	2.67
Formal	16	10.67
Total	150	100

Source: Own survey result, 2021

Table 7 presents the production and productivity of onion in the sample households. Households in the study area allocated about one hectare of land for onion and nearly one hectare for tomato production for the season. The average seed rate for onion was 5 kg/ha whereas that of tomatoes was 0.75kg/ha. Another important finding shown in the Table is the yield of the two crops. The average yield for onion was 303.25 quintal per hectare whereas the yield of the tomatoes was 463.74 quintal per hectare. The yield of both onion and

tomatoes are by far higher than the national average yield of 75.3 quintal and 58.13 quintals per hectare, respectively as reported by CSA (2020). On average the sample household produced a total of 33814kg of onion from 1.06 hectares of land.

Table 1. Vegetable production and productivity of the sample households per household

Crop	Particulars	Obs.	Mean	Std. Dev.	Min	Max
Onion	Area (ha)	150	1.058	0.552	0.25	3.25
	Seed used (kg)	150	4.965	2.231	1.25	12.5
	Seed rate (kg/ha)	150	5.001	1.022	2.462	7.5
	Production (kg)	150	33813.5	24026.7	4125	141375
	Yield (kg/ha)	150	30325.3	9695.1	16000	50000
Tomatoes	Area (ha)	150	0.944	0.514	0.25	2.5
	Seed used (kg)	150	0.739	0.467	0.125	2
	Seed rate (kg/ha)	150	0.754	0.121	0.333	1
	Production (kg)	150	45181.7	30130.1	6875	140000
	Yield (kg/ha)	150	46374.3	12183.4	13333	76000

Source: Survey result, 2021

Factors affecting Onion Seed supply

The regression analysis showed that, out of the thirteen explanatory variables included in the model, eight of them had a significant impact on onion seed use by the sampled household (Table 8). The significant explanatory variables are sex, age, education level, farm experience, access to credit, land size of the household, price of onion seed and income from onion of the sampled household. Both the F statistic [F (13,136) = 26.46, P<0.000)] and the R-square value = 0.716 indicated that the overall fitness of the model is good. The R-square value offers the total variation in the dependent variable (quantity of onion seed used) that is explained by the independent variables. The result suggested that 71.6% of the total variation in the quantity of onion seed used by the sample household was explained by the explanatory variables included in the model.

The regression output result revealed that the age and sex of the household head negatively affected the quantity of onion seed used at a 1% significance level. The result suggested that as the age of the household head increases by one year, the amount of onion seed used decreases by 0.032 kilograms, ceteris paribus. This finding suggested that the younger are better at using vegetable seeds as compared to the older household heads.

The model output result further indicated that, as expected, the level of education of the household head had a positive impact on the quantity of onion seed used at a 1% level of significance. As the education of a household head increases by one year of schooling, the quantity of onion seed used increases by 0.139 kilograms of seed, keeping other factors constant.

Another variable that had a significant but negative impact on the quantity of onion seed used is access to credit. Access to credit enhanced the financial capacity of the farmer to use the improved varieties of seed and other inputs; thereby increasing onion productivity was reflected in the utilization of seed supplied/used by farmers households. If there is access to credit to farmers in the production of vegetables, there is an increase in the productivity of onion production which in turn increases the household's income. It is also hypothesized here that access to credit has a positive influence on the level of vegetable production.

The price of onion seeds plays a role in how much farmers plant. As expected, the study found a negative relationship between seed price and seed use. This means that when the price of onion seeds goes up, farmers tend to plant less. However, the impact is quite small. Even if the price of seeds increases by one Ethiopian Birr (ETB), the amount of seeds used only decreases by a tiny amount, 0.0002 units.

Table 8. Factors affecting the quantity of Onion seed used by the sampled households (dependent variable: Onion seed use)

	Coef.	Robust St. Err.	t-value	p-value
Sex of HHH	-0.6822	0.334	-2.04	0.043**
Age of HHH	-0.0357	0.016	-2.23	0.027**
Education of HHH	0.1395	0.0526	2.65	0.009***
Family size	0.0718	0.10718	0.67	0.504
Farm experience	0.348	0.0702	4.95	0.000***
Off/non-farm income	-0.1681	0.2334	-0.72	0.473
Oxen owned	0.2226	0.2046	1.09	0.279
Credit access	0.5551	0.3142	-1.77	0.080**
Extension contact	0.0140	0.021	0.66	0.513
Market information	-0.2933	0.3487	-0.84	0.402
Onion Seed price	-0.0002	0.00003	-7.25	0.000***
Income	3.71e-06	7.68e-07	4.83	0.000***
Constant	0.7516	0.9047	0.83	0.408
Mean dependent var.	4.965	SD dependent var.		2.231
R-squared	0.716	Number of obs.		150
F-test	26.46	Prob. > F		0.000
Akaike crit. (AIC)	455.62	Bayesian crit. (BIC)		497.77

***, **, * significant at 1%, 5% and 10% significance level head

Source: Analysis result, 2021.

Conclusion

According to the study's findings, various factors were discovered to have an impact on the quantity of onion seed supplied (used) by the sample households. The age of the household head was discovered to have a negative impact on the amount of onion seed used, meaning that the younger people were better at expanding onion farms in the study area. On the other hand, educated household heads were positively associated with the quantity of onion seed use, implying that enhancing education among farm households can increase onion production. According to the regression results, the price of onion seed

was adversely connected to the quantity of onion seed used. Ethiopia's seed system requires significant improvement to function efficiently. A key element is ensuring strong collaboration and dedicated roles for each stage of the three-pronged seed system (foundation, registered, certified). Additionally, several areas deserve focus: An effective seed system in Ethiopia relies on several key pillars. Understanding farmers' needs through proper seed demand assessment is essential to producing the right seeds in the right quantities. Involving farmers in the planning process ensures that developed varieties address their specific challenges and preferences. An inclusive seed production system that integrates all qualified producers maximizes production capacity. To encourage farmer participation, the seed system must offer high-quality seeds, ensure timely availability through convenient locations, and maintain fair pricing. Furthermore, increasing seed production cycles throughout the year can help bridge the gap between demand and supply. Stronger linkages between research institutions and seed producers are crucial for translating research advancements into improved seeds that benefit farmers. Finally, developing and implementing a clear, comprehensive national seed strategy provides a roadmap for the overall direction and improvement of Ethiopia's seed system.

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RESEARCH PAPER

Determinants of Onion and Cabbage Market Outlets Choices of Smallholder Farmers: The Case of Holeta town, Oromia Regional State

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Abstract

Market participation and outlet choices in smallholder farmers hold considerable potential revealing suitable opportunity preparations necessary for providing better incomes and worthwhile livelihoods for the study area. Hence this study was intended to analyze determinants of market outlet choice in Holeta district, Oromia National Regional State. To achieve the objectives, 147 vegetable producers were selected following simple random sampling techniques. The collected data were analyzed using a multivariate probit model. The model results show that the probability of choosing wholesalers, middlemen, retailers, and consumers' market outlets was significantly affected by education level, farm experience, land size, family size, distance to near market, input utilization and credit access. Therefore, it is recommended that the government and community should improve rural infrastructure, and smallholder farm productivity through improved inputs (such as vegetable seed, chemicals and fertilizers), encouraging education, promoting farmers' cooperatives, strengthening market information delivery systems, upgrading roads in both rural and peri-urban areas, encourage market integration initiatives, and establish accessible market outlets with improved facilities in the remote rural villages to promote production and market outlets choice in smallholder vegetable farmers.

Keywords: Market outlet, market participation, multivariate probit model, vegetable

Introduction

Ethiopia's agricultural sector is still the backbone of the country, but its development depends on the pace of agricultural growth and the transformation of the current subsistence-oriented production system into market-oriented production (Diriba, 2020; Plecher, 2020). Vegetables are an important source of nutrition in Ethiopia and are primarily produced by horticulture (Tadele and Derbew, 2015). They are integrated into mixed farming systems and are an important commercial activity in Ethiopia. It is also an efficient way to address poverty reduction, take care of consumers, and offer new market opportunities (Rahiel et al., 2018; Bezabih *et al*., 2015; Chala and Chalchisa, 2017).

The government has also developed the second Growth and Transformation Plan for the period 2016–2020 to become a middle-income country by 2025 by improving agricultural productivity and commercialization. Among the strategies, market-oriented agricultural production policies are the central one (Mekonnen, 2015) and the government tries to promote the production and marketing of high-value agricultural products including vegetables to increase the competitiveness of farmers in national and

international markets (Tufa *et al*., 2013). Cabbage is the second most important vegetable crop, followed by red pepper in the study area (MoA, 2011).

Ethiopian vegetable output markets are characterized by inadequate transport networks, inadequate market information systems and underdeveloped industrial sectors. Smallholder vegetable producers have little information about the market demand, price and times to sell their products (Ibrahim et al, 2012). Vegetable production is a source of income and home consumption for a large proportion of rural households. However, the perishable nature of the product, price fluctuation due to the seasonality of the product and intermediary malpractices, lack of market linkage, price volatility, unidentified market behavior and character altogether impede the potential gains that could have been attained from the existing opportunities. In this case, smallholders' decisions to choose an appropriate market outlet are important farm-household-specific decisions. However, smallholders' decisions about selling their produce in alternative market outlets are made by evaluating the returns in expected utility for each market outlet. By the way, when farmers choose among alternative market outlets, there may be self-selection, as farmers choose their marketing outlets based on their perceptions of the returns they will get from each market outlet (Burhan *et al.*, 2022).

Nahusenay *et al*. (2018) stated that the total land holding of the household, family size, the volume of vegetables produced and marketed, usage of irrigation technologies, interaction with extension agents, and access to market information and vegetable marketing significantly improve the livelihoods of smallholder producers. Similarly, other studies (Hagos *et al*., 2020; Hao *et al*., 2018; Megerssa et al., 2020; Ola & Menapace, 2020) were conducted on the different factors affecting the marketing/commercialization of agricultural products by using different methods of data analysis.

Previous empirical studies such as Amare (2017), Demelash (2018), Ephrem (2016) and Shewaye (2016) attested that the driving factors that lead to the inefficiency of the Vegetable market include limited or lack of improved seed access, price volatility, high taxes and various fees at different levels, overvalued exchange rate, poor coordination skill amongst traders, lack of product quality standard, unfair trade practices imposed by brokers at the market place, lack of market information to producers, long market chain, and few market channel choices, limited grading and quality control systems, and asymmetry of price information that result in a low market participation of producer and a low share of the price for producers (excessive margins from traders over producers).

Different studies such as: Abebe *et al*. (2018), Kassa *et al*. (2017), and Shewaye (2016) identified the factors affecting market outlet choice in different parts of Ethiopia. They found that farmer's decision to choose various market outlets is affected by demographic, socio-economic, institutional, farmer and marketing characteristics. Even if the efforts made by the government to transform smallholder farmers from subsistence to commercial farming system were done, the performance has been considered below expectations (NPC (National Planning Commission, 2016). On top of this, smallholder farmers are unable to benefit from such empirical findings due to unimproved varieties, high transaction costs, lack of infrastructure and inadequate extension services. Thus, improving smallholder farmers' marketing infrastructure is a decisive and important pathway to ensure household income and economic growth of the country (Abafita *et al*., 2015).

In spite of the fact that vegetable production is crucial for rural economic growth and poverty reduction, limited attention has been given to the sector. Correspondingly, MoFED (2015) argued that so far public research on vegetable crops were negligible and major public policies and attention of extension agents were mainly focused on staple crop production.

Therefore, such types of studies are relevant and help resolve the underlying product-

specific marketing inflexibilities and thereby not only enhancing the livelihoods of farmers but also assisting the governments in their effective planning and specific intervention in the area, offers a better insight to enrich the stock of knowledge limited in the literature regarding smallholder farmer's market outlet choices in vegetable marketing and can also serve as an input for policymakers and researchers who wish to work in this area. Hence, this study is aimed to full fill these noticeable gaps and investigate market outlet choices of smallholder farmers in Holeta town Oromia regional state.

Materials and methods

Description of the Study Area

Holeta town is one of the towns of Oromia National Regional State. In the north, south, and east the town is surrounded by Welmera district and in west by Ejere district. Astronomically the town is located between the latitude of 90 01′ 08″N - 90 06′ 15″N and longitude of 380 26′ 40″E -380 32′46″E. During early 2004, several cities were separated from the district administration and bounders from their neighboring woreda and Holeta city is not an exception. Therefore, Holeta town separated from Welmara woreda with distinct boundaries and administration.

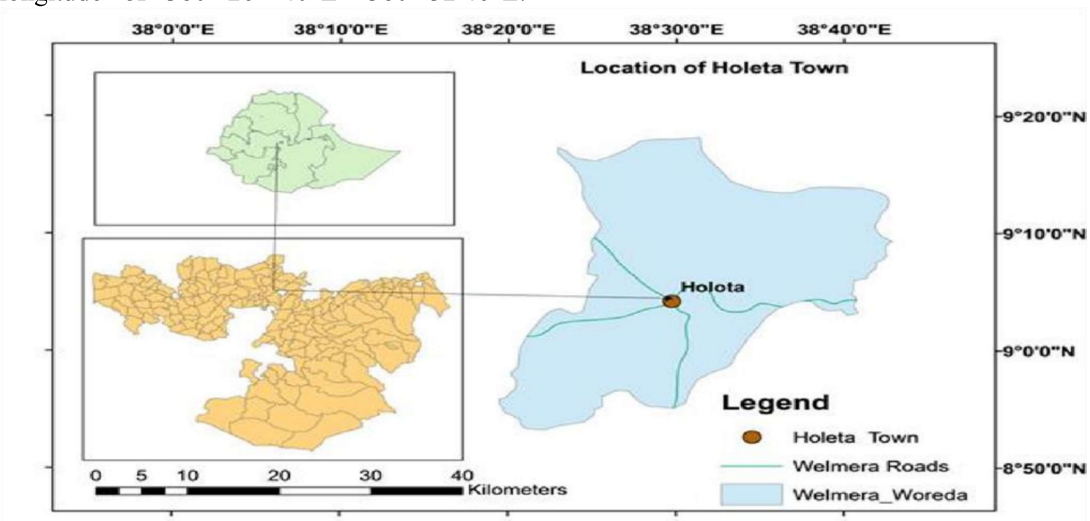

Figure 2: Map of the study area

The altitude ranges between 2250-2500m above sea level. The town is 30 km away from Addis Ababa to the west. The town has eight kebeles with the total area coverage of 5,550 ha (55.5km2) out of which five kebeles are rural kebeles. The town was founded for the purpose of the military services in the 1900s and it had the status of a Municipality in 1948 (Welmera Woreda Agricultural Bureau 2014).

Sampling Methods and Size Determination

The population of this study is vegetable smallholder producers found in the Holeta districts, Oromia National Regional State, Ethiopia. There is a total of 8 kebeles in Holeta town administration of which five kebeles are producers of vegetables. The populations of this study were smallholders' producers of vegetables found in the Holeta district, Oromia regional state, Ethiopia

Multi-stage sampling methods were used to select vegetable-producing districts and sample farm households. In the first stage, 8 kebeles in the district were stratified in terms of vegetables producing and non-producing kebeles of which five of them were selected as vegetable producers. In the second stage, two

kebeles were selected randomly from five potential vegetable-producing kebeles. Finally, from the randomly selected two kebeles, 147 sample households were selected randomly based on proportional to the population size by using Yamane's (1967) formula.

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

$$n = \frac{2483}{1+2483(0.08^2)} = 147 \quad \ldots\ldots 2$$

Where, n = sample size, N= population size (sampling frame) and e = level of precision considered 8%.

Table 1. Sample kebeles by their respective household heads

S.N	Sample kebeles	Vegetable producers	Sample size
1	Birbirsa siba	994	50
2	Medagudina	1489	97
	Total	2,483	147

Source; own survey result

Data Type, Sources and Methods of Collection

Both primary and secondary data were used for this study. Primary data were collected from randomly selected smallholder vegetable-producing farmers in Holeta town using a pre-tested semi-structured questionnaire. The primary data constitute information related to the factors affecting market participation and outlet choice. In addition, Focus Group Discussion (FGD) and Key Informant Interviews were also collected to supplement the primary data. Secondary data were also collected from Holeta town Agriculture office and Central Statistical Authority (CSA).

Methods of Data Analysis

Descriptive statistical analysis such as frequency, percentage and standard deviations were used to explain the marketing characteristics and vegetable marketing channels.

The producer's decision to participate in a given market is derived from the maximization of expected utility from these markets and helps to reduce some risks than a single market channel (Arinloye *et al*., 2015). Econometric models such as multivariate probit/logit and multinomial probit/logit are useful models for the analysis of categorical choice-dependent variables. Multinomial models are appropriate when individuals can choose only one outcome from among the set of mutually exclusive and collectively exhaustive alternatives. However, in the study area, there are several market outlets (Primary cooperatives, wholesalers, Assemblers, Retailers and consumers) and farmers have the possibility to select more outlets simultaneously to maximize the expected utility due to this there are some overlapping and many farmers sell to more than one market outlet. In view of this, most previous similar research applied multivariate probit (MVP) to analyze the determinants of market outlets choices in a different part of Ethiopia (Shewaye *et al*., 2016; Kassa *et al*., 2017; Abebe *et al*., 2018; Tadie *et al*., 2019). Similarly, this study applied the MVP model to analyze the simultaneous influence of the explanatory variables on market outlet choices, while allowing the unobserved and/or unmeasured factors (error terms) to be freely correlated as well as the relationships between the choices of different market outlets (Greene, 2012).

The observed outcome of market outlet choice can be modeled following random utility formulation. Consider the i^{th} farm household (i=1, 2, 3…N), facing a decision problem on whether or not to choose the available market. Let Uk represent the benefits of farmers choosing the m^{th} market outlet where m denotes the choice of the whole seller (Y1), middlemen (Y2), Retailer (Y3) and consumer (Y4). The producer decides to choose the m^{th} market outlet if, Y* = Uk* - U0 > 0. The net benefit (Y_{im*}) that the farmer derives from choosing a market outlet is a latent variable determined by the observed explanatory variable (Xi) and the error term (εi):

$$Y_{im*} = \beta_{im}X_{im} + \varepsilon_{im} \quad Y_{im} = \{1, \ if y > 0, \ 0 \ Otherwise \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where Y_{im} (m=1, 2,…..4) denotes the market outlet choices, (Y_1) for wholesales, (Y_2) for middlemen, (Y_3) for retailers, (Y_4) for consumer, available for i^{th} vegetable producer, (i = 1.....n); X_{im} *is a* vector of explanatory variables, β_{im} denotes the vector of parameters to be estimated, and ε_{im} are random error terms jointly follow a multivariate normal distribution with zero conditional mean.

Results and Discussion

Descriptive Statistics Results

In order to understand and compare respondents' group differences between non-participants and participants in the smallholder vegetable markets, descriptive statistics such as percentage and standard deviation. The survey result indicated that out of 147 sampled households, 105 were vegetable market participants whereas the remaining 42 households were nonparticipants. Vegetable producers sell different amounts of vegetables in the market depending on different demographic and socioeconomic characteristics of the household. On average, vegetable producers sold 18,857.14 kilograms of vegetables (onion and cabbage) in the 2021 production season.

Table 2; displays the different responses of smallholder vegetable farmers market Channels/outlets choices when selling their produce to vegetable markets. One of the most used market outlets by producers is the wholesale outlet which was chosen by about 66(62.86%) of respondents, while about 44(41.9%) of respondents sold to the retailer. As Table 2 result depicted, 35(33.33%) of the producers had also chosen middlemen outlets whereas 27(25.71%) of the sample households sold directly to the consumer's outlets.

Table 2. Description of smallholder farmers' vegetable market outlets

Supply Decision	Vegetable market outlets							
	Wholesale		Middlemen		Retailer		Consumer	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	66	62.86	35	33.33	44	41.9	27	25.71
No	39	37.14	70	66.67	61	58.1	78	74.29

Source: own survey data, 2021/22

Multivariate probit model results

In the model result Wald chi2(52) = 135.47 was significant at a 1% significance level, which indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the factors included in the model is satisfactory; thus, the MVP model fits the data reasonably well. Likewise, the model is significant because the null that the choice decision of the four vegetable market outlets is independent was rejected at a 1% significance

level. The results of the likelihood ratio test in the model indicate the null that the independence between market outlet choice decision (rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0) is rejected at 1% significance level and there are significant joint correlations for four estimated coefficients across the equations in the models.

There are differences in market outlet selection behavior among producers, which are reflected in the likelihood ratio statistics of the estimated correlation matrix shows that the correlation between each pair of dependent variables rho41 (correlation between the choice for consumer and wholesaler outlet) and rho32 (correlation between the choice for retailer and middlemen outlet) are negative interdependent and significant at the 1% probability levels. This finding leads us to the conclusion that smallholder vegetable producers delivering to consumer outlets are less likely to distribute to wholesalers and also those involved in retail market outlets are less likely to deliver their vegetables to the middlemen outlets.

The multivariate probit model was employed in determining the factors that affected the choice of market outlets among smallholder vegetable producers. The study found four outlets for the smallholder vegetable produce, which are wholesalers, middlemen, retailers and consumers. The producers thus sold their vegetables among these outlets in various proportions. If the inter-relationships involved in selling among the various outlets are not taken into consideration, it may result in biased estimates of the factors that influence the choice of the produce market outlets. The multivariate probit model was thus used to explain the interdependent relationships of the market outlets. The result in Table 7 shows that out of 13 explanatory variables entered in the multivariate probit model that can affect the market channel choice of vegetables in the district seven variables had a significant effect on market outlet choice. These were educational level, farm experiences, market distance, family size of household, land size, input access, and credit access were found to significantly affect the market outlet choice behavior of vegetable producers.

As the result of Table 3, Land size for vegetables has a positive and significant effect on the likelihood of the probability of wholesaler and middlemen outlet at a 1% significance level while it has a negative and significant effect on the likelihood of choosing consumer outlet at 5%. This implies households with a large area of cultivated vegetables probably produce large volumes and are less likely to sell to consumer outlets who buy in small quantities, instead supplying to wholesalers and middlemen a combination of market outlets rather than delivering only to single market outlets. The result agrees with Ebrahim *et al*. (2020) and Mebrat (2014) who found that farm size positively affected the probability of farmers' choice of wholesaler outlets as farmers with larger total landholding produce large amount and prefer to sell in bulk quantities. This is also in line with Hawlet *et al* (2019) who found that farmers with more landholdings produce large amounts and prefer to sell this large amount to wholesalers rather than consumers.

Input access has a positive and significant effect on the likelihood of choosing wholesaler and consumer outlets at 1% and 5% significant levels (Table 3). This may indicate the more input access to farmers, the more diversity their vegetable production on their limited land and supply to address diverse market outlets including wholesalers and consumers. This indicates that using modern agricultural inputs like chemical fertilizers improves the yield of onion and cabbage so that farmers can decide to supply their large quantity to the wholesale market outlets. Beyene *et al*. (2020) also reported that chemical fertilizer positively and significantly influenced haricot bean production and market participation.

The effect of distance to the nearest market was found to affect positively and significantly wholesaler and middlemen vegetable market outlets at 1% and 5% probability levels, respectively (Table 3). On the contrary, the likelihood of choosing a retailer and consumer market outlet is significantly and negatively influenced by distance to the nearest market at a 1% probability level. This indicated that farmers whose residences are far from the

nearest urban market are more interested in selling their product to wholesalers and middlemen market outlets in bulk quantity rather than selling to retailers and consumer outlets. The implication of choosing wholesale and middlemen market outlets is also because of the perishable characteristics of the product, farmers would prefer to sell large quantities at one time rather than spending more time in consumers' outlets. This result is in line with Melese *et al.* (2018). The result is consistent with Chaimiso et al (2022) discovered retail market outlet of potato marketing was negatively and significantly affected by market distance. This result is also in line with Shewaye *et al*., (2016), and Arinloye *et al*. (2015).

As the model result of Table 3, Household size has a negative and significant relationship with the likelihood of choosing retailers and consumer outlets at a 1% significant level. As can be understood from the results, the probability of choosing a retailer and consumer channel decreased when the number of families increased. This result is in line with Temesgen *et al*. (2017) who found that as the number of families increased, the probability of participating in vegetable production decreased. Contrary to this Efa and Tura et al. (2018) indicated that large family size enables better labor endowment so that households are in a position to travel to get wholesalers in the district or nearby town markets. Similarly, a study showed that having a large family size was better for delivering output to the better-pricing market outlet (Nigel and Silveira, 2023).

As Table 3 depicts, the educational level of the household head has a negative and significant effect on the market channel choice of a consumer at a 1% significant level. The reason is that education increases the ability of farmers to analyze relevant market information and choose the best market outlet that is expected to give a better price for their produce. Formal education enhances the information acquirement and adjustment abilities of the farmer, thereby improving the quality of decision-making on choosing profitable and productive market outlets. This result is consistent with the findings of Addisu (2017) who found that educated farmers were less likely to sell potato through consumer outlets because educated farmers value their time devoted to marketing activities. It is also in line with Ebrahim *et al.* (2020) who revealed that the education level of household heads negatively affected the likelihood of choosing consumer outlets in vegetable marketing.

Table 3 shows farm experience in vegetable production affects market outlet choice positively and significantly for the likelihood of choosing retail outlets at a 1% significant level. This is because experienced households are expected to have market information and linkage with retailers who buy more quantities at better prices. This is in line with Chaimiso et al (2022) found that the more experienced vegetable farmers who produce a huge amount of products might choose a wholesaler or retailer channel choice to sell a huge amount of products rather than a collector or consumer. It is also supported by Efa and Tura, (2018) discovered that the experience of the producer had a positive effect on choosing better market outlet choices.

As the result of Table 3, Access to credit has a positive and significant effect on households "choice of consumer market outlet at a 5 % significance level. Access to credit would enhance the financial capacity of the farm households to purchase the necessary materials and increase output. The credit further enhanced their capacity to accommodate harvesting, packing and transport costs required in selling to more market outlets including consumers. The finding is similar to Kirimi et al. (2013) who found that access to credit enables mango producers to attain better yields thus being able to sell to high-value markets for better returns. The result is also in line with Hawlet *et al*. (2020) and Melese *et al*. (2018) found that access to credit has a positive and significant effect on choosing a consumer market outlet for marketing onion.

Table 3. Multivariate Probit Result

Market Outlet		Wholesale	Middlemen		Retailer		Consumer	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Marital	0.025	0.192	-0.306	0.2337	0.154	0.159	0.111	0.186
Family Size	-0.148	0.115	0.089	0.1230	-0.453**	0.118	-0.375**	0.136
Education Level	0.134	0.134	0.193	0.1176	-0.044	0.103	-0.514**	0.178
Farm Experience	0.018	0.015	0.020	0.0163	0.029**	0.013	-0.021	0.016
Off-farm Income	-0.079	0.170	-0.148	0.1800	-0.135	0.160	0.106	0.182
Land size	1.493**	0.428	0.972**	0.3233	0.447	0.301	-0.564*	0.337
extension Service input	0.120	0.224	0.145	0.2145	-0.014	0.206	0.085	0.227
Access	1.243**	0.526	0.725	0.5641	0.056	0.397	0.970*	0.506
Price	-0.338	0.304	-0.301	0.3343	0.230	0.231	-0.343	0.286
Market Distance	0.362**	0.164	0.291*	0.1682	-0.327**	0.140	-0.494**	0.178
Transport Access	-0.332	0.340	0.379	0.3523	0.070	0.289	-0.152	0.322
Market info Access	-0.039	0.353	-0.440	0.3208	-0.406	0.311	-0.298	0.356
Credit Access	-0.274	0.319	-0.512	0.3312	0.133	0.280	0.567**	0.337
Cons	-3.234	1.848	-3.440	1.8968	1.590	1.499	4.748	1.980

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2 (6)21.4213 Prob > chi2 = 0.0015

Source: Own survey data, 2021; ***significant at 1%, **significant at 5%, *significant at 10%

Conclusion

Ethiopia's population experiences malnutrition due to heavy dependency on cereal crops. Vegetable crops are a very important source of nutrition in a country like Ethiopia. The rate of agricultural growth depends upon the pace with which the current subsistence-based production system is transformed into market-oriented production. The study was carried out in Holeta district, Oromia regional state. The amount of vegetables supplied to the market was significantly influenced by the family size, land size, farm experience, input access and inverse Mill's ratio (LAMBDA). The multivariate probit model was run to identify factors determining farmers' market outlet choice decisions. The model result indicated that the probability of choosing wholesalers' marketing outlets for vegetables was significantly affected by land size, input access, and market distance. Similarly, the probability of choosing a middleman marketing outlet was affected by land size and distance to the market. The probability of choosing retailers' market outlets was significantly affected by family size, distance to nearby markets and farm experience. The probability of choosing consumers' market outlet was significantly affected by educational level, family size, land

size, input access, market distance and credit access.

Price factors should play a great role in market participation as well as the choice of marketing outlet. This implies that farmers with price information are more likely to participate in vegetable marketing and are in the right position to make careful decisions on an appropriate market outlet. Therefore, the farmer should always have access to price information. Awareness creation on sources of market information, in what way to select appropriate market outlets should be prearranged by the government agriculture offices and market experts in the study area. Therefore, the Provision of technical advice to the farmers on cabbage and onion production and marketing, enhances the participation decision, volume of participation and choice of efficient market channel.

On the other side, agriculture offices, research institutes, universities; and different nonprofit institutions should provide training to increase the dissemination of new and modern production processes, tools, and technologies as well as improved practices and vegetable seeds for farmers. Finally, further research is needed on determinants of vegetable farmers' production schedule to know their best marketing season to get optimum prices.

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RESEARCH PAPER

Evaluation of Ethiopian Fenugreek (*Trigonella foenum-graecum*) Genotypes against Powdery Mildew (*Erysiphe polygoni*) at Ambo District, West Shewa, Ethiopia

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Abstract

Fenugreek (Trigonella foenum-graecum L) is one of the most important spice crops in Ethiopia. Ethiopia has suitable environmental conditions for fenugreek production and the crop has extraordinary economic importance in the country. However, Powdery mildew caused by Erysiphe polygoni is an economically important disease, especially during the flowering and pod formation stage of the crop and causes significant loss in grain quality as well as quantity. In order to identify resistance materials against the disease, one hundred Ethiopian fenugreek accessions were evaluated. The study was conducted in Ambo district, Bayo Qurbi Farmer's Association Farmers Training Center, during the 2020 main cropping season with alpha lattice design. The study was made under natural epidemic conditions with objectives to identify the source of resistance in Ethiopian Fenugreek materials for further resistance breeding programs and to identify a high-yielding genotype for sustainable production. The study identified two fenugreek genotypes namely 31088 and 237983 showing resistant reactions and 43 genotypes as moderately resistant type. The remaining genotypes showed susceptible reactions. The study also identifies three higher-yielding accessions namely 20428, 35190 and 31087. The results of the study conclude having a crossing program between resistant accessions (31088, 237983) and higher yielding accessions 20428, 35190 and 31087 can result in improved resistance and better yield. The study would be helpful for the development of the breeding program and further improvement of fenugreek crop. Accordingly based on this study genotypes 31088 and 237983 can be used as resistant material for further resistant breeding.

Keywords: Disease resistance, evaluation, fenugreek, powdery mildew

Introduction

Fenugreek (*Trigonella foenum-graecum* L) is an annual plant that belongs to the family Fabaceae (Balodi *et al.,* 1991). Fenugreek is used both as a herb (the leaves) and as a spice (the seed), often called Methi in Urdu/ Hindi/ Nepali). Documented history indicated that it is regarded as the oldest known medicinal plant (Lust, 1986) and has been referred to as a medicinal herb both in Indian Ayurvedic and traditional Chinese medicines (Tiran, 2003). Ancient literature, religious scripture, travel records and anecdotes from different continents and different periods of human history, record a wide variety of medicinal properties associated with fenugreek (Lust, 1986). Medicinal uses vary from wound healing to bust enhancement and, from the promotion of lactation in weaning mothers to its use as a sex stimulant or aphrodisiac (Petropoulos, 2002; Tiran, 2003).

Fenugreek is indigenous to countries on the Eastern shores of the Mediterranean but widely cultivated in India, Argentina, Egypt, Morocco, Southern France, Algeria, Ethiopia, and Lebanon (Kakani *et al*., 2014). Fenugreek was used as a diet both in humans and animals to deliver health benefits. Such diets include dishes with liberal amounts of fenugreek seeds,

which are very popular in southern India (Srinivasan, 2006). Fenugreek hay contains more soluble protein than alfalfa hay, and there is a growing interest in Canada in fenugreek as an alternative feed crop for dairy cows (Acharya *et al*., 2008).

Ethiopia has suitable environmental conditions for fenugreek production and the crop has extraordinary economic importance in the country. It is one of the seed spices, which farmers and private investors in different parts of the country are eager to produce (David, 2002; Birhane, 2012) and is among the major seed spices grown in West Shewa. It is also one of the crops selected for specialization at the national level for their export potential. Currently in Ethiopia, fenugreek covers an area of about 34,603.85 hectares with an average national productivity of about 1.3 t/ha (CSA, 2017). This is less than the attainable yield (1.7 t /ha) under good management practices (CSA, 2017). Despite its extraordinary economic importance, the yield of fenugreek under farmers' conditions is very low (1.28 t/ha). This is much less than the attainable yield under good management practices (5.2 t/ha). The wide yield gap is attributed to the lack of improved varieties for different agroecological zones of Ethiopia, poor agronomic practices, poor soil fertility, diseases (powdery mildew) and insect pests (borer). (Girma *et al*., 2016).

Among many biotic factors that constrained fenugreek production and productivity, the diseases powdery mildew and wilt referred to as the major diseases of the crop mainly cause reduced number of pods per plant, number of seeds per pod and seed weight resulting in significant yield losses up to 40% (Yonas, 2017). Powdery mildew of fenugreek caused by *Oidium* sp. is an important and serious disease, especially during the flowering and pod formation stage of the crop and causes significant yield losses of up to 33.27% as well as grain quality losses (Prakash and Saharan, 2002). The disease was frequently prevalent in fenugreek in the central highlands of Ethiopia with an incidence of about 95% and severity ranges from 20 to 80% (Nigussei *et. al.* 2008). Though powdery mildew is the number one yield constraining disease of the crop, less management effort and less focus is given to the management of the disease in fenugreek.

As host plant resistance is the best and most economical for plant disease management, investigations of resistance genotypes are paramount in breeding for disease resistance. However, the evaluation of fenugreek genotypes in Ethiopia has been an infant and on a small scale. Only some variety of development efforts have been reported from Sinana and Debreziet Agricultural Research Center in the country (DZARC, 2004; SARC, 2005). Consequently, fenugreek takes a considerably low research priority in the national agricultural research system. As the empathy of the other seed spice crops has improved, it is applicable that a more thorough and systematic evaluation of fenugreek genetic resources must be conducted in Ethiopia conditions (Mustefa 2006). Therefore, this study aims to evaluate Ethiopian fenugreek accessions against powdery mildew to identify resistant and high-yielding genotypes for utilization in further breeding programs.

Materials and methods

Description of Study Areas

The study was conducted at Bayo Kurbi Farmers Training Center (FTC) in Ambo district of West Shewa zone of Oromia National Regional State. Ambo district is located at $8^0$56'30'' N latitude and $37^0$47'30''-$37^0$55'15'' E longitude in central Ethiopia, 114 km west of Addis Ababa.

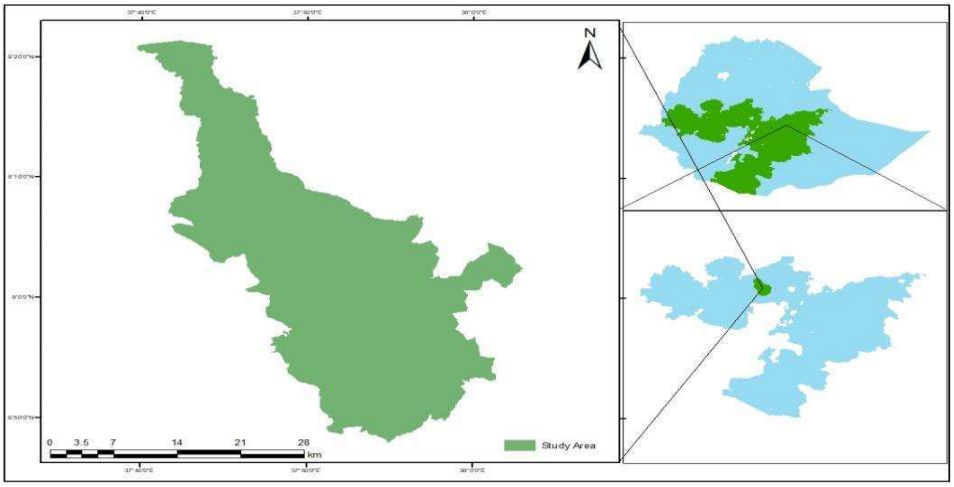

Figure 1: Map of the study area (Source EBI Documentation)

Planting Materials

One hundred fenugreek accessions along with one local check were used for this study. The majority of the accessions represent the national collection from major growing regions of Ethiopia. The materials were obtained from the Ethiopian Biodiversity Institute (EBI), while one local variety was obtained from a local farmer.

Experimental Design

The experimental units were laid out in an alfa lattice design in three replications. The plot size was a single row of 1.5 m long and spacing of 0.30 m between rows and 0.10 m intra-row spacing. A replication holds 4 blocks and contains 100 entries (genotypes) including local checks. Spacing between sub-blocks was 1 m and between the two replications was 1.5 m. Therefore, the total experimental area was 11 m X 30.3 m = 333.3 m^2.

The seed and fertilizer rates were applied as per the national recommendation for the crop. i.e. 25 kg ha-1 of seed, 100 kg ha-1 for NPS and 50 kg ha-1 UREA. Half the rate of Urea and full dose NPS were applied at planting time and the second half rate of Urea was applied at 30 days after emergence immediately after first weeding. The trial was kept weed-free using hand weeding.

Data Collected and Measurements

Disease assessment

Progress of disease development in the plants was observed five times during the epidemiological period. Disease assessments were made by observing the plants that were planted on the plot or row and recorded as diseased and healthy. Disease incidence and severity was taken as a standard procedure (Saxena *et.al.*, 1984).

Disease Incidence (DI): is the number of infected plants over the total number of plants per plot and expressed in percentage. It was calculated by using the following formula.

$$\text{PDI} = \left(\frac{\text{Number of infected plants in the sampling unit}}{\text{Total number of plants in the sampling unit}}\right) \times 100$$

Disease severity (DS) Powdery mildew severities were recorded from 5 randomly tagged plants in a plot starting from the appearance of the disease and then at five-day intervals throughout the season. Disease scoring was done based on the percent leaf area infected with a 0–9 rating scale (Saxena *et.al.*, 1984). 0= No disease, 1= 0–3 Few small leaf lesions, 2= 3–6 Few lesions on few leaves with no stem lesions, 3= 6–12 Few lesions on few leaves or with superficial stem lesions, 4= 12–25 Few well-formed leaf lesions or superficial stem lesions, 5= 25–50 Few well-formed leaf

lesions or enlarging stem lesions, 6= 50–75 Many large leaf lesions or deep stem lesions with abundant sporulation or plant more than 50% defoliated, 7= 75–87 Many large coalescing leaf or stem lesions, over 75% of plant area affected or defoliated, 8= 87–100 Plants largely defoliated, leaf or stem with abundant sporulating lesions and 9= 100% Plants dead.

The severity scores were converted into percent severity index (PSI) for analysis using the following formula:

$$\text{PSI} = \frac{\text{Sum of numerical ratings } x \text{ 100}}{\text{No. of plants scored } x \text{ Maximum score of the scale}}$$

The disease severity indexes obtained from different assessment periods were used to calculate the Area under the Disease Progress Curve (AUDPC-%day) of the recording period. The area under the disease progress curve (AUDPC) was calculated for each genotype. AUDPC-% day is used to quantify and summarize the severity of the disease over time. AUDPC was calculated from the severity data following the formula by Saxena *et.al.* (1984).

$$\text{AUDPC} = \sum_{i=1}^{n-1} 0.5(Xi + Xi+1)(ti+1 - ti)$$

Whereas: AUDPC = area under disease progress curve, n is the total number of assessment times, t_i is the time of the i^{th} assessment in days from the first assessment date, x_i is the percentage of disease severity at i^{th} assessment. The sum total of disease progress during the different assessment periods was used as the final AUDPC-%day at the end of the epidemiological period. AUDPC-%day values were then used in different analysis packages in the study to compare the amount of disease among plots with different genotypes.

After analysis of the disease parameters (PDI, PSI and AUDPC) the genotypes in the population were categorized into five categories namely resistant (0–10%), moderately resistant (11–20%), moderately susceptible (21–40%), susceptible (41–60%) and highly susceptible (>60%) based on the PSI value.

Phonological Parameter

Days of emergence: recorded as the number of days from planting to at which 50% of the plants in the experimental unit emerge or germinate.

Days to 50% flowering: was recorded as the number of days from planting to 50% flowering of a row

Days to 95% physiological maturity: was recorded as the number of days from planting to 95% full maturation/physiological maturity in an experimental unit.

Grain filling period (GFP):- was calculated as the difference between days to maturity and days to flowering (DM-DF).

Yield and Yield Components

Plant height (PH) in cm: - An average height of plants at 90% physiological maturity was measured from the ground level to the tip of the main stem.

Number of branches per plant: taken average number of primary branches (branches from the main stem) from five plant randomly sampled plants.

Number of nodes per plant (NNPPl): - was determined as the average number of nodes from the five sampled plants per plot.

Number of pods per plant (NPPPl):- was determined as an average of pods counted from five randomly selected plants per plot.

Pod length (PL) in cm: the average length of pods measured in cm from five randomly sampled plants per plot

Above Ground Biomass (AGBM) (ton/ha): The weight of yield total biomass per plot was measured after harvest sun dry and converted to ton/ha.

Number of seeds per pod (NSPP): the average number of seeds counted from total pods from five randomly sampled plants per plot.

Hundred seed weight (HSW) (g):- Hundred seeds were counted from each plot and the weight was taken using electronic balance and adjusted at 12% moisture content.

Seed yield per plant (SYPPl) (g):- was recorded as the average weight of seeds from five randomly sampled plants and adjusted at 12% moisture content.

Seed yield per hectare (SYPH) (ton/ha): The weight of yield of seeds per plot was measured and adjusted at 12% content and converted to ton/ha.

Harvest index (HI):- was calculated by dividing grain yield per plot by total above-ground dry biomass yield per plot and multiplied by hundred.

$$HI = \frac{\text{Grain Yield}}{\text{BiomassYield}} x100$$

Data Analysis

Analysis of variance (ANOVA) was made using SAS version 9.2 (SAS, 2008). When ANOVA indicates significant differences among treatment means. Mean comparisons were carried out using the least significant difference (LSD) at a 5% level of significance. Correlation analysis was made to analyze the relation of the disease parameters to yield parameters. And principal component analysis was made to group the genotypes.

Results and discussions

Disease Development and Genotype Reaction

The result of the screening indicated that the evaluated genotypes fall into four disease reaction classes namely resistant, moderately susceptible, susceptible and highly susceptible. Of the hundred genotypes evaluated two genotypes namely 237983 and 31088 exhibited resistance reactions against the powdery mildew pathogen with the mean disease severity of 9.49 and 7.19, respectively (Table 1). Similarly, forty-three of the genotypes showed moderate resistance, fifty-four were susceptible and one genotype showed highly susceptible disease reaction with mean disease severity of 69.92 (Table 1). The study revealed that there was disease reaction variation among Ethiopian fenugreek landraces. Different scholars also found that there is a variation among fenugreek genotypes in reaction to powdery mildew pathogen. According to Prakash and Saharan (1999) amongst 44 lines screened against powdery mildew, GC-39 and UM-32 were found free from fungal infection, whereas GC-7, GC-20, and UM-34 were categorized as resistant varieties.

The current results indicated that there were high variations in disease development between the resistant and susceptible genotypes which reveals resistant genotypes potentially reduce the disease incidence and severity than the susceptible genotypes (Table 1). This finding is in agreement with the finding of Raje *et.al.* (2003) who reported that there was a heavy incidence of powdery mildew in susceptible check while less incidence in resistance material.

In the current study, apart from powdery mildew, other fenugreek disease was recorded during the field experiment, including Cercospora leaf spot and rust in cropping seasons. Although these diseases occurred prior to powdery mildew in cropping season it was at very low intensity. With regard to insect pests, in cropping seasons the major insect pests that occurred during the experiment included Cutworm (*Agrotis ipsilon*), damaging them near the ground in the seedling stage and leaf miners were found to severely damage the Fenugreek plants soon after flowering and pod formation.

Table 1. Reaction of fenugreek genotypes against powdery mildew (*Erysiphe polipolygoni*) under field condition

S/N	Genotypes/ Accessesion	Percent disease severity	Host plant reaction	S/N	Genotypes/ Accessesion	Percent disease severity	Host plant reaction
1	234032	40.41	S	51	9239	36.75	MS
2	235133	55.92	S	52	31087	40.39	S
3	237983	9.49	R	53	28601	23.52	MS
4	31088	7.19	R	54	31100	32.17	MS
5	28506	46.45	S	55	53078	57.92	S
6	230880	36.54	MS	56	215820	43.01	S
7	239070	40.02	S	57	221732	43.35	S
8	215731	37.75	MS	58	28599	54.44	S
9	238247	50.91	S	59	Check	37.68	MS
10	19906	34.44	MS	60	212877	48.35	S
11	28603	23.47	MS	61	28607	30.46	MS
12	18754	31.9	MS	62	28615	49.22	S
13	28613	41.81	S	63	20429	51.56	S
14	237511	36.7	MS	64	28605	56.16	S
15	20430	31.13	MS	65	53010	56.71	S
16	28612	39.65	MS	66	53008	53.27	S
17	18835	43.73	S	67	19908	42.46	S
18	231320	69.92	HS	68	239061	55.53	S
19	53096	54.67	S	69	239067	53.7	S
20	31085	42.49	S	70	212658	50.3	S
21	220020	44.35	S	71	29561	36.65	MS
22	35194	29.87	MS	72	28602	52.36	S
23	237982	44.89	S	73	230673	59.25	S
24	19903	34.8	MS	74	28604	53.89	S
25	20428	22.99	MS	75	28598	40.17	S
26	19902	24.86	MS	76	29563	56.32	S
27	28600	52.92	S	77	28606	49.88	S
28	220022	31.24	MS	78	19907	53.26	S
29	28596	28.76	MS	79	212775	37.08	MS
30	220024	25.14	MS	80	220023	47.7	S
31	29560	33.08	MS	81	35191	50.3	S
32	29564	36.28	MS	82	53021	44.93	S
33	53097	33.45	MS	83	18840	41.99	S
34	220025	29.34	MS	84	28614	36.18	MS
35	18834	25.15	MS	85	212777	51.16	S
36	31091	32.65	MS	86	53018	52.56	S
37	230536	24.87	MS	87	15331	39.94	MS

Table 1: continued

S/	Genotypes/	Percent	Host	S/	Genotypes/	Percent	Host plant
38	216899	50.52	S	88	19905	48.09	S
39	28610	38.51	MS	89	230674	36.23	MS
40	234034	33.54	MS	90	17732	45.65	S
41	53016	59.93	S	91	53062	54.93	S

42	53072	52.76	S	92	28609	40.68	MS
43	9563	37.21	MS	93	28608	47.79	S
44	53014	44.12	S	94	19904	36.05	MS
45	35190	30.62	MS	95	237985	36.32	MS
46	53009	35.48	MS	96	236621	55.31	S
47	53061	34.76	MS	97	53064	55.6	S
48	18822	32.8	MS	98	31102	43.72	S
49	53080	35.36	MS	99	28611	56.09	S
50	53089	47.15	S	10	28505	44.96	S

R= Resistant, MS= moderately susceptible, S= susceptible HS= highly susceptible

Analysis of variance (ANOVA) results for agronomic and disease parameters also revealed that different fenugreek genotypes responded differently to the infection of powdery mildew. The results showed AUDPC and all agronomic parameters except plant height (PH) and number of primary branches per plant (NPBPPl) were significantly different among tested genotypes (Table 2, 3 & 4). The analysis of variance showed that there is no significant difference among genotypes concerning plant height (PH) and number of primary branches per plant. This might be related to the late coming of the pathogen at which the plant grows to its optimum height and primary branch and the two traits were similar in fenugreek genotypes. Typical powdery mildew symptoms of infection were observed beginning from sixty-two (62) days post-germination. The symptoms began from the lowest leaf among the plants. The powdery mildew appeared as small white powdery spots on the lower and upper surfaces of the leaves. The powdery mildew progresses to other leaves as the plants grow. These were observed virtually on all the leaves of the plants. Gupta *et al*. (1997) screened 110 lines of fenugreek for resistance to Erysiphe polygoni, Rhizoctonia solani and Fusarium oxysporum in Hisar (Haryana). None of the genotypes was completely resistant to all three pathogens. However, GP 75, GP 82, GP 94, GP and PEB were the moderately resistant lines and lines are significantly different in the yield and yield component parameters.

Table 2. Reaction of fenugreek germplasm for phenological parameters under powdery mildew disease (*Erysiphe polygoni*) under field conditions

ENTRY	**ACC**	**Phonological parameters**			
		DE	DF	DM	GFP
1	234032	6.33bcde	49.00	132.67	83.67
2	235133	6.33bcde	45.67	132.00	86.33
3	237983	6.33bcde	49.33	131.33	82.00
4	31088	6.00cd-e	47.33	131.67	84.33
5	28506	6.67ab-e	47.00	134.33	87.33
6	230880	6.00cde	47.67	132.00	84.33
7	239070	6.67ab-e	44.33	131.00	86.67
8	215731	7.33abc	45.33	132.00	86.67
9	238247	5.33e	47.00	131.33	84.33
10	19906	7.33abc	46.33	132.33	86.00
11	28603	6.33bcde	47.00	131.67	84.67
12	18754	6.33bcde	49.00	133.67	84.67
13	28613	5.67de	46.33	132.33	86.00
14	237511	6.33bcde	48.00	134.67	86.67

15	20430	6.33bc-e	47.33	131.33	84.00
16	28612	6.33bc-e	47.00	132.67	85.67
17	18835	7.00abcd	45.67	132.00	86.33
18	231320	6.00cde	46.33	132.67	86.33
19	53096	7.00abcd	47.00	134.67	87.67
20	31085	6.00cde	48.67	134.67	86.00
21	220020	6.33bcde	46.67	133.00	86.33
22	35194	7.00abcd	45.67	130.33	84.67
23	237982	7.67ab	45.33	131.00	85.67
24	19903	7.67ab	46.00	130.67	84.67
25	20428	6.33bcde	47.33	132.33	85.00
26	19902	7.33abc	47.00	131.00	84.00
27	28600	7.33abc	46.33	132.00	85.67
28	220022	7.00abcd	49.00	134.33	85.33
29	28596	6.67ab-e	47.33	131.33	84.00
30	220024	5.67de	47.00	133.00	86.00
31	29560	6.67ab-e	45.67	131.00	85.33
32	29564	6.33bcde	48.33	133.00	84.67
33	53097	6.00cde	49.33	132.00	82.67
34	220025	7.00abcd	47.00	132.67	85.67
35	18834	7.33abc	46.00	131.67	85.67
36	31091	7.00abcd	47.67	133.00	85.33
37	230536	6.67ab-e	47.67	135.33	87.67
ENTRY	**ACC**	**Phonological parameters**			
		DE	DF	DM	GFP
38	216899	6.33	46.00	134.00	88.00
39	28610	6.33	47.33	132.33	85.00
40	234034	7.33	45.00	130.67	85.67
41	53016	6.00	46.67	132.67	86.00
42	53072	7.67	46.33	131.00	84.67
43	9563	7.33	46.00	131.33	85.33
44	53014	6.33	47.00	132.00	85.00
45	35190	7.33	46.33	132.67	86.33
46	53009	5.33	47.00	132.00	85.00
47	53061	7.00	45.33	132.67	87.33
48	18822	6.33	48.00	133.00	85.00
49	53080	7.33	47.67	131.33	83.67
50	53089	5.67	49.00	132.67	83.67
51	9239	7.00	46.00	131.00	85.00
52	31087	6.67	48.00	132.67	84.67
53	28601	7.33	46.67	132.33	85.67
54	31100	7.67	46.00	131.00	85.00
55	53078	6.33	47.00	131.67	84.67
56	215820	6.00	48.33	131.67	83.33
57	221732	6.00	46.00	131.67	85.67
58	28599	6.67	46.67	131.33	84.67
59	Check	6.67	47.67	132.33	84.67
60	212877	6.67	46.33	131.00	84.67
61	28607	7.33	46.67	130.67	84.00
62	28615	6.00	46.00	131.00	85.00
63	20429	6.33	46.67	132.67	86.00
64	28605	6.00	46.00	131.67	85.67

65	53010	6.33	47.67	133.00	85.33
66	53008	7.00	46.00	130.33	84.33
67	19908	7.00	47.33	131.33	84.00
68	239061	6.00	45.33	133.67	88.33
69	239067	6.67	46.67	131.67	85.00
70	212658	7.67	46.67	131.00	84.33
71	29561	6.33	48.00	132.33	84.33
72	28602	6.67	46.67	132.00	85.33
73	230673	6.33	47.67	132.00	84.33
74	28604	6.33	48.00	134.00	86.00
ENTRY	**ACC**	**Phonological parameters**			
		DE	DF	DM	GFP
75	28598	6.00	49.00	133.33	84.33
76	29563	5.67	47.33	132.67	85.33
77	28606	5.67	48.67	133.00	84.33
78	19907	7.00	47.33	131.00	83.67
79	212775	7.33	46.33	131.00	84.67
80	220023	7.00	47.00	131.67	84.67
81	35191	7.33	47.00	131.00	84.00
82	53021	7.33	46.67	131.00	84.33
83	18840	7.00	46.67	130.67	84.00
84	28614	8.00	45.00	130.67	85.67
85	212777	7.67	45.67	131.67	86.00
86	53018	7.00	45.00	133.00	88.00
87	15331	6.67	46.00	133.67	87.67
88	19905	7.00	45.67	135.67	90.00
89	230674	6.67	47.00	132.00	85.00
90	17732	6.67	44.67	133.33	88.67
91	53062	7.00	46.33	131.67	85.33
92	28609	6.33	48.33	135.33	87.00
93	28608	6.33	47.33	132.00	84.67
94	19904	6.33	47.00	134.33	87.33
95	237985	5.67	46.67	132.33	85.67
96	236621	6.33	48.33	134.00	85.67
97	53064	7.33	46.00	131.33	85.33
98	31102	7.67	45.33	130.67	85.33
99	28611	7.00	47.67	134.33	86.67
100	28505	8.00	45.33	130.00	84.67
min		5.33	44.33	130.00	82.00
max		8.00	49.33	135.67	90.00
mean		6.67	46.86	132.24	85.38
Cv		13.33	3.06	0.95	1.90
LSD		1.4315	2.3097	2.029	2.6094
P value		0.03	0.0031	<0.0001	0.02

DE= Days of emergence, DF= Days to 50% flowering, DM=Days to maturity, GFP=Grain filling pried

* = significant at p<0.05, ** =significant at p<0.001 and *** = significant at p< 0.0001

Table 3. Reaction of fenugreek germplasm for growth parameters under powdery mildew disease (*Erysiphe polygoni*) under field conditions

ENTRY	ACC	Growth parameters				
		PL	NPBPPl	NSBPPl	NNPPl	NPPPl
1	234032	8.33	3.20	0.67	15.80	3.53
2	235133	9.40	3.67	2.67	29.60	12.47
3	237983	7.53	3.10	2.00	26.20	8.33
4	31088	7.93	4.63	1.67	25.87	9.07
5	28506	9.23	3.93	2.00	33.60	14.00
6	230880	8.00	4.13	0.67	28.30	11.87
7	239070	8.33	3.40	2.33	29.93	9.33
8	215731	8.53	3.40	2.00	31.70	11.77
9	238247	8.97	4.33	2.60	25.93	10.80
10	19906	8.43	5.40	2.00	28.07	9.60
11	28603	8.30	4.00	1.00	29.87	11.53
12	18754	7.83	3.67	2.00	18.67	6.93
13	28613	8.70	3.37	1.67	30.40	7.73
14	237511	8.90	4.40	2.33	30.07	9.27
15	20430	7.17	4.47	1.60	13.33	3.20
16	28612	8.33	4.77	1.67	32.00	12.60
17	18835	9.23	5.07	2.33	32.87	11.80
18	231320	7.97	4.07	1.67	29.13	8.53
19	53096	8.27	4.07	1.67	32.40	13.17
20	31085	8.30	4.33	0.67	27.73	10.53
21	220020	7.77	3.73	2.00	24.60	9.67
22	35194	7.70	3.77	2.33	35.07	12.47
23	237982	8.70	3.87	1.00	37.47	15.73
24	19903	7.60	4.23	2.33	35.83	11.80
25	20428	9.33	3.93	1.87	29.53	12.00
26	19902	7.07	4.07	1.13	24.80	8.53
27	28600	7.93	4.37	1.67	28.37	11.07
28	220022	7.53	4.03	1.47	23.53	10.33
29	28596	8.57	4.17	1.33	30.83	11.43
30	220024	9.20	3.57	1.33	28.47	10.33
31	29560	7.73	3.47	1.00	21.13	7.33
32	29564	7.33	4.33	2.33	29.80	11.87
33	53097	8.07	3.87	1.73	23.37	8.47
34	220025	8.53	3.90	2.13	19.10	6.53
35	18834	9.33	3.90	3.00	25.87	9.80
36	31091	7.77	5.33	2.00	28.47	10.53
37	230536	8.07	3.67	1.67	30.73	9.93
38	216899	8.53	4.03	2.67	35.27	14.00
39	28610	7.33	4.67	2.27	17.53	6.73
40	234034	8.50	3.77	2.33	29.50	10.40
41	53016	7.93	3.93	2.00	31.93	12.13
42	53072	8.07	4.00	2.33	31.07	10.53
43	9563	8.17	4.40	1.93	30.53	12.53
44	53014	8.53	3.73	2.00	32.77	13.10
45	35190	7.80	4.33	1.40	36.00	13.67
46	53009	8.70	3.80	2.33	34.40	13.47
47	53061	7.47	3.47	2.47	27.07	12.00
48	18822	8.03	4.03	2.30	30.70	9.67

49	53080	9.17	4.00	2.00	34.53	12.60
50	53089	7.97	4.07	2.00	24.60	8.73
51	9239	8.50	3.93	2.67	25.80	7.80
52	31087	9.33	3.80	2.33	29.13	10.17
53	28601	7.43	4.60	2.07	27.87	9.20
54	31100	7.17	4.80	3.00	25.47	12.00
55	53078	9.63	4.03	2.33	30.80	12.00
56	215820	8.63	4.80	2.33	24.93	8.87
57	221732	7.87	3.20	1.00	25.73	7.13
58	28599	8.03	3.70	2.33	29.97	11.13
59	Check	9.00	4.43	1.80	27.13	9.87
60	212877	7.87	4.40	0.87	24.53	8.07
61	28607	8.97	3.40	1.27	27.93	9.33
62	28615	7.90	5.00	2.00	26.07	9.53
63	20429	8.17	3.77	1.00	20.20	6.87
64	28605	7.43	4.00	2.67	23.57	8.60
65	53010	7.67	4.10	1.67	26.13	11.60
66	53008	7.50	3.70	2.33	16.60	7.17
67	19908	8.13	3.57	2.33	24.33	10.63
68	239061	8.50	4.53	2.00	24.93	12.47
69	239067	8.40	4.30	2.00	29.20	8.87
70	212658	8.07	4.23	0.93	24.13	9.27
71	29561	7.87	3.47	2.67	26.53	9.27
72	28602	8.37	3.70	1.93	25.73	9.73
73	230673	9.53	4.30	2.33	33.87	12.93
74	28604	8.20	4.90	2.33	33.53	13.63
75	28598	9.03	4.47	2.33	32.87	12.73
76	29563	8.30	3.93	1.87	28.13	10.87
77	28606	8.30	4.00	1.67	27.00	10.33
78	19907	9.33	3.73	2.33	31.13	11.97
79	212775	7.80	3.57	2.67	24.10	8.33
80	220023	9.17	3.93	2.33	26.80	8.67
81	35191	7.40	4.27	2.83	26.33	9.07
82	53021	7.67	4.20	0.47	25.20	10.60
83	18840	6.47	3.60	2.67	31.27	9.37
84	28614	8.20	4.20	2.67	29.40	9.13
85	212777	8.17	3.27	1.73	26.13	9.80
86	53018	8.00	3.87	2.00	32.47	12.47
87	15331	8.33	4.80	2.00	22.47	8.60
88	19905	7.17	3.13	1.67	28.93	8.47
89	230674	7.53	3.80	1.67	22.67	8.47
90	17732	9.63	3.33	2.33	32.40	12.60
91	53062	8.33	4.07	1.67	13.07	3.13
92	28609	8.53	3.53	1.67	33.87	13.00
93	28608	9.07	3.90	1.33	27.40	11.40
94	19904	8.67	4.20	1.67	19.47	6.87
95	237985	8.30	4.73	1.67	27.93	10.60
96	236621	7.70	3.80	2.00	34.07	8.47
97	53064	8.47	3.77	1.67	34.40	11.07
98	31102	8.90	4.73	3.00	41.00	12.07
99	28611	9.53	3.43	2.67	33.13	12.67
100	28505	9.43	3.60	2.00	37.40	11.33

min	6.47	3.10	0.47	13.07	3.13
max	9.63	5.40	3.00	41.00	15.73
mean	8.27	4.03	1.94	28.05	10.20
Cv	6.5	11.63	5.45	18.89	26.2
LSD	0.8669	4.4565	0.3534	4.3123	0.5914
P value	<0.0001	0.55	<0.0001	<0.0001	<0.0001

PL= Pod length, NPBPP= number of primary branches, NSBPP= Number of secondary branches, NNPPl =Number of nodes per plant, NPPPl= Number of pods per plant

* = significant at p<0.05, ** =significant at p<0.001 and *** = significant at p< 0.0001 and ns=non-significant

Table 4. Reaction of fenugreek germplasm for AUDPC, yield and yield component parameters under powdery mildew disease (*Erysiphe polygoni*) under field conditions

ENTRY	**ACC**	**Yield and disease parameters**						
		NSPP	SYPPl	HSW	SYPH	AGBM	HI	rAUDPC
1	234032	7.80	0.23	1.13	0.71	18.67	16.944	44.44
2	235133	8.60	0.36	1.43	1.53	37.00	19.785	54.35
3	237983	3.93	0.14	0.83	0.42	8.33	23.452	7.69
4	31088	5.40	0.19	0.97	0.66	11.67	24.688	5.46
5	28506	8.67	0.29	1.30	1.39	39.00	16.551	48.98
6	230880	6.73	0.22	1.20	0.87	22.33	18.978	33.98
7	239070	7.80	0.27	1.33	1.50	36.00	18.406	37.5
8	215731	7.47	0.24	1.23	1.34	28.67	20.105	37.96
9	238247	6.00	0.31	1.33	1.66	28.67	25.205	50.09
10	19906	7.47	0.30	1.50	1.23	29.33	17.991	34.44
11	28603	8.27	0.30	1.80	1.44	27.33	24.159	25.09
12	18754	8.40	0.37	1.63	1.44	46.67	14.56	36.11
13	28613	6.80	0.28	1.47	0.77	24.67	13.675	37.69
14	237511	8.27	0.41	1.53	1.86	37.33	22.714	38.24
15	20430	6.80	0.14	1.33	0.76	25.00	13.45	30.65
16	28612	8.00	0.23	1.40	1.01	35.00	14.226	38.98
17	18835	7.93	0.30	1.33	1.36	28.33	21.735	44.07
18	231320	7.00	0.38	1.50	1.91	35.33	24.003	69.26
19	53096	6.93	0.27	1.13	1.39	29.00	21.156	59.91
20	31085	6.93	0.33	1.23	1.45	30.00	19.681	45.46
21	220020	7.33	0.20	1.30	0.81	20.67	19.967	47.22
22	35194	6.87	0.32	1.30	1.44	22.33	29.076	33.33
23	237982	5.93	0.21	1.27	1.13	20.33	25.614	42.69
24	19903	7.13	0.33	1.07	1.27	24.00	23.345	31.48
25	20428	6.87	0.26	0.93	1.00	23.33	19.151	21.76
26	19902	6.27	0.24	0.83	0.73	14.67	19.358	26.57
27	28600	7.73	0.25	1.17	1.46	19.00	30.285	54.63
28	220022	8.20	0.25	1.37	1.22	21.00	26.383	30.46
29	28596	6.13	0.34	1.23	1.56	26.00	25.172	26.85
30	220024	6.00	0.17	1.10	0.74	18.67	18.826	21.94
31	29560	7.20	0.33	1.17	1.46	31.67	22.458	31.39
32	29564	5.27	0.21	1.23	1.04	16.33	29.778	33.06
33	53097	5.53	0.23	1.20	0.87	17.33	23.022	30.65
34	220025	5.20	0.19	1.17	0.79	16.33	22.814	26.3
35	18834	7.33	0.13	1.30	0.81	19.00	19.02	28.61
36	31091	5.40	0.28	1.03	0.86	17.33	22.441	34.54

37	230536	7.73	0.32	1.13	1.26	27.00	21.894	27.41
38	216899	7.73	0.25	1.37	1.46	29.67	22.374	53.06
39	28610	6.13	0.27	1.40	1.39	24.67	21.718	41.48
40	234034	6.67	0.28	1.20	1.17	24.67	21.515	30.56
41	53016	7.13	0.23	1.17	0.87	26.33	14.885	63.43
42	53072	7.07	0.22	1.17	1.28	23.33	24.188	49.44
43	9563	6.53	0.23	1.17	1.16	25.33	22.415	34.07
44	53014	6.40	0.19	1.20	0.87	17.00	23.206	42.59
45	35190	7.20	0.40	1.60	1.99	35.67	24.111	30.83
46	53009	8.80	0.35	1.43	1.53	38.33	19.095	33.24
47	53061	8.47	0.32	1.50	1.67	32.33	23.278	36.39
48	18822	10.53	0.35	1.63	1.70	49.00	14.097	37.5
49	53080	9.07	0.40	1.30	1.45	40.67	17.512	32.13
50	53089	6.80	0.27	1.37	0.74	27.33	13.232	46.67
51	9239	8.20	0.26	1.43	0.99	26.67	16.956	36.76
52	31087	9.27	0.41	1.50	2.18	47.67	19.632	38.33
53	28601	7.07	0.26	1.53	1.26	29.33	19.226	25.19
54	31100	6.93	0.14	1.27	0.76	26.33	13.076	36.2
55	53078	7.87	0.39	1.57	1.56	34.67	21.48	57.59
56	215820	6.87	0.18	0.87	0.93	22.33	18.405	41.02
57	221732	9.53	0.40	1.47	1.94	43.67	20.062	42.04
58	28599	8.60	0.32	1.37	1.45	37.67	15.67	52.13
59	Check	8.07	0.31	1.20	1.16	31.67	16.19	34.63
60	212877	6.87	0.20	1.30	0.59	22.00	11.821	46.67
61	28607	6.73	0.21	1.03	0.70	18.00	17.672	28.15
62	28615	5.87	0.26	1.00	1.08	24.00	15.174	45.09
63	20429	7.80	0.28	1.40	1.56	34.67	18.587	48.43
64	28605	7.93	0.26	1.17	1.07	24.33	20.47	54.63
65	53010	8.20	0.22	1.43	1.09	34.67	13.542	59.54
66	53008	8.13	0.27	1.37	1.48	26.67	23.976	55.65
67	19908	6.27	0.20	0.87	0.66	14.33	23.409	39.81
68	239061	8.47	0.33	1.40	1.53	43.33	16.294	61.85
69	239067	7.93	0.27	1.40	1.35	28.00	23.532	52.5
70	212658	7.47	0.19	1.17	1.15	26.00	18.874	48.43
71	29561	6.60	0.14	1.47	0.65	26.67	12.236	34.63
72	28602	5.80	0.25	1.50	1.13	26.67	16.682	55.37
73	230673	7.40	0.28	1.30	1.19	31.67	17.655	56.02
74	28604	8.13	0.35	1.10	1.14	35.33	15.091	55.19
75	28598	7.60	0.19	1.23	0.73	22.00	14.909	42.96
76	29563	6.60	0.33	1.03	0.92	15.67	26.207	52.69
77	28606	7.07	0.12	0.80	0.33	21.33	7.022	56.2
78	19907	5.60	0.21	1.03	0.53	16.67	15.076	50.74
79	212775	5.13	0.19	1.30	0.56	16.33	15.569	34.07
80	220023	6.07	0.12	1.13	0.40	15.00	12.741	46.39
81	35191	5.40	0.22	0.77	0.77	15.67	16.913	52.69
82	53021	6.47	0.23	0.97	0.84	18.67	18.56	41.94
83	18840	7.00	0.33	1.20	1.20	28.33	18.097	41.67
84	28614	5.40	0.17	1.20	0.70	17.33	18.294	35.19
85	212777	6.13	0.28	1.20	1.21	23.33	22.284	54.17
86	53018	8.40	0.22	1.27	1.26	27.67	19.495	53.89
87	15331	7.20	0.15	1.27	0.72	24.67	12.965	47.5
88	19905	7.27	0.26	1.03	0.76	18.67	17.471	48.43
89	230674	6.73	0.17	1.03	0.75	21.33	15.201	38.61

90	17732	8.07	0.29	1.30	1.27	29.67	20.074	47.31
91	53062	6.67	0.12	1.37	0.63	19.33	15.536	53.24
92	28609	8.20	0.17	1.00	0.53	20.33	11.132	47.04
93	28608	7.40	0.26	1.27	1.14	29.67	17.197	48.33
94	19904	8.07	0.27	1.07	1.17	25.67	21.119	42.41
95	237985	8.40	0.36	1.37	1.93	41.00	19.075	34.26
96	236621	6.67	0.26	1.33	0.79	20.67	19.424	56.85
97	53064	8.13	0.31	1.50	1.91	38.33	19.993	52.41
98	31102	8.27	0.40	1.40	1.76	34.67	22.003	41.48
99	28611	9.13	0.18	1.23	0.87	39.00	10.354	56.39
100	28505	7.93	0.32	1.53	1.41	34.00	18.769	40.65
min		3.93	0.12	0.77	0.33	8.33	7.02	5.46
max		10.53	0.41	1.80	2.18	49.00	30.29	69.26
mean		7.23	0.26	1.26	1.14	26.83	19.22	41.75
Cv		9.42	17.48	18.97	50.98	35.09	34.27	31.75
LSD		4.2638	0.0737	0.384	0.9372	15.144	10.615	21.394
P value		<0.0001	<0.000	<0.00	0.02	<0.0001	0.08	<0.0001

NSPP = number of seed per plant, SYPPl= Seed yield per plant, HSW=Hundred seeds weight in gram, SYPH = Seed yield per hector, AGBM = Above ground biomass, HI= Harvest index, and rAUDPC= residual Area under disease progress curve

* = significant at p<0.05, ** =significant at p<0.001 and *** = significant at p< 0.0001 and ns=non-significant

Correlation Analysis

The Pearson's correlation coefficients between possible pairs of agronomic traits and disease parameters tested using SAS software (SAS, 2009). The results showed that correlation among most of the yield and yield components in fenugreek are positive and significant (Table 5). Seed yield per hector (SYPH) had positive and significant correlations with all paired yield component traits except pod length. The result revealed that genotypes with better (longer) in grain filling period are better in their seed yield and the plants bearing more number of nodes per plant, more number of pods per plant and more number of seeds per pod produce more seed yield. Indeed genotypes with better hundred seed weight had higher above ground biomass and seed yield per hector. Thus, selection for better yield component traits will bring about a definite improvement in above ground biomass and seed yield. The trait (SYPH) is non-significant with disease parameters, area under disease progress curve (AUDPC) and disease progress rate (DPR) (Table 5). The disease parameters AUDPC and disease progress rate were non- significant with most yield component parameters except grain filling period and number of seed per pod. This result revealed that the pathogen mainly affect the phonological development of the genotypes and finally affect the number of seeds per plot. Generally, this study revealed that resistant genotypes were significantly reducing the disease parameters (Table 1 & 5) but low yielder. This phenomenon happened in non-elite resistant material because they mobilize most of their genetic resource for disease response than yield response. This indicate that as powdery mildew is a series disease in fenugreek and the resistant genetic materials identified in this study are important for cross breeding with elite high yielding genotypes.

Table 5. Correlation between different agronomic traits of fenugreek genotypes and their final disease reaction to powdery mildew disease

	GFP	PL	NNPPl	NPPPl	NSPP	SYPPl	HSW	AGBM	HI	rAUDPC	PDR
PL	0.106ns										
NNPPl	0.211*	0.353**									
NPPPl	0.237*	0.348**	0.820**								
NSPP	0.356**	0.253*	0.205*	0.188ns							
SYPPl	0.168ns	0.137ns	0.342**	0.213*	0.511**						
HSW	0.193ns	0.135ns	0.107ns	0.033ns	0.515**	0.480**					
AGBM	0.274**	0.249*	0.237*	0.217*	0.799**	0.695**	0.665**				
HI	0.000ns	-0.107ns	0.143ns	0.156	-0.183	0.331**	0.037ns	-0.181ns			
rAUDPC	0.314**	0.112ns	0.070ns	0.134ns	0.277**	0.092ns	0.115ns	0.254*	-0.218*		
PDR	0.325**	0.096ns	0.033ns	0.094ns	0.281**	0.098ns	0.066ns	0.228*	-0.177	0.644**	
SYPH	0.257*	0.131ns	0.286**	0.245*	0.577**	0.842**	0.607**	0.773**	0.426**	0.137ns	0.146ns

GFP =Grain Filling Pried, PL=Pod Length, NNPPl =Number of Nod Per Plant, NPPPl =Number of Pod Per Plant, SYPPl =Seed Yield Per Plant, HSW=Hundred seeds weight,
AGBM = Above ground biomass, HI= Harvest index, rAUDPC= residual Area Under Disease Progress Curve, PDR=Percent Disease Reduction and SYPH = Seed yield per hector

Key: *=significant @ p<0.05; **=significant @ P,0.01; ns=non-significant

Cluster Analysis

Hierarchal clustering of the average linkage method with squared Euclidian distance were performed using MINITAB14 software (MINITAB (2003). The distances between clusters were calculated using average linkage method of squared Euclidian distance. The average linkage Euclidian distance technique of clustering produced a more understandable portrayal of the 100 fenugreek accessions by grouping them into six clusters, whereby different members within a cluster is being assumed to be more closely related in terms of the trait under consideration with each other than those members in different clusters. Similarly, members in clusters with non-significant distance were assumed to have more close relationship with each other than they are with those in significantly distant clusters. In this study the hundred genotypes were grouped in to five clusters. Among the five clusters maximum inter cluster distance (ED=9.642) was found between cluster 3 and cluster 6 indicating possibility of inter crossing the genotype of the two clusters. On the other hand minimum inter cluster distance (3.700) was recorded between cluster 2 an 4 indicating their genetic relatedness. The highest intra clusters some of square (947.379) was recorded in cluster 2 which consists of 74 genotypes.

Table 6. Clusters of 100 fenugreek genotypes in to different diversity classes

Clusters of 100 fenugreek genotypes									
Cluster-1	Cluster-2					Cluster-3	Cluster-4	Cluster-5	Cluster-6
G1	G2	G7	G74	G75	G35	G3	G12	G23	G88
G15	G55	G8	G56	G33	G84		G14	G97	
G39	G73	G40	G62	G50	G78		G95	G100	
G91	G58	G86	G11	G71	G80		G48	G98	
G64	G69	G72	G45	G6	G77		G52		
G66	G59	G85	G22	G60	G81		G49		
G34	G93	G24	G83	G70	G20		G18		
G87	G65	G27	G45	G82	G37		G68		
G94	G13	G42	G25	G26	G28		G31		
	G46	G43	G30	G67	G92		G51		
	G93	G47	G32	G89	G99		G63		
	G5	G10	G96	G61	G54				
	G38	G17	G41	G21	G4				
	G19	G16	G44	G51	G9				
	G90	G36	G76	G79					

G= Genotype

Cluster 1: It consisted of 9 genotypes which were collected from Oromia and Amhara regions. Members in this cluster laid on intermediate value in all the traits under consideration.

Cluster 2: It consisted of 74 genotypes, which were early in days to flowering, intermediate in biomass yield, number of pods and seeds per plant and number of seeds per pod. Among these clusters the genotype /accession, 35190 is high yielder. Accessions in this cluster also exhibited lower with hundred seed weight, seed yield per plant harvest index and 1 accessions exhibited resistant and the remaining exhibited moderately susceptible as well as susceptible to powdery mildew disease.

Cluster 3: It consisted of 1 genotype characterized by late in days to flowering; low in seed and biomass yield and number of seeds and pods per plant high in hundred seed weight. It also exhibited intermediate, number of seeds per pod harvest index and resistant to powdery mildew disease.

Cluster 4: It had 11 genotypes which exhibited early growth periods, short days to flowering; low in hundred seed weight and intermediate in both biomass yield and number of pods per plant. Among these clusters the accession, 237985 exhibited intermediate seed yield per plant, seeds per pods, harvest index and resistant to powdery mildew disease.

Cluster 5: It consisted of four genotypes. The accessions under this category were relatively inferior in most of the traits investigated. It was characterized by intermediate days to flowering; exhibited lowest in all traits under studied except hundred seed weight, harvest index and moderately susceptible to powdery mildew.

Cluster 6: It consisted of one genotype from Tigrai. It was found to be the most superior accession regarding the traits studied. This accession was characterized by low in hundred seed weight and harvest index. However, this particular accession also required longer period to maturity, characterized by intermediate seed and biomass yield per plant, number of seeds and pods per plant and seeds per pod and moderately susceptible response to powdery mildew. In general, the differences between the clusters were mainly attributed to the variation in all traits. Other traits such as days to flowering, biomass yield and number of seeds per plant have contributed equally well for cluster constellations.

Table 7: Mean and range of genetic diversity in disease resistance and seed traits of the hundred clusters of *T. foenum-graecum*

Characters	Clusters													
	1			**2**			**3**	**4**			**5**			**6**
	Min	Max	Mean	Min	Max	Mean	Mean	Min	Max	Mean	Min	Max	Mean	Mean
DE	5.8	7	6.5	5.2	7.9	6.7	6.3	5.5	7.3	6.4	7.2	8.1	7.6	7.1
DF	45.8	48.6	46.8	44.5	49.6	46.9	49.5	44.9	48.9	47	45.2	46.1	45.5	45.9
DM	130.2	134.1	132.5	130.1	135.2	132.2	131.6	131.2	134.5	132.7	130.1	131.6	130.9	135.4
GFP	84.3	87.7	85.8	82.6	88.4	85.3	82.1	83.9	88.2	85.7	84.8	85.8	85.4	89.5
NPBPPl	3.2	4.8	4	3.2	5.4	4	3.1	3.5	4.7	4	3.6	4.7	4	3.2
NSBPPl	0.7	2.5	1.8	0.6	3	2	2	1.1	2.5	2	1	2.9	1.9	1.7
NPPPl	15.6	33.5	20.3	18.4	35.2	28.7	27.8	21	33	27.4	34.4	39	36.9	7.1
NSPP	5.5	8.8	7.4	5.1	9.2	7	4.7	7.2	10	8.4	6.5	8.8	8	27.7
NNPPl	5.1	12.8	7.6	7.7	14.5	10.5	12	9.1	11.1	10.2	9.5	14.8	11.6	7.2
PL	7.4	8.7	8.2	6.5	9.6	8.3	7.7	7.9	9.3	8.5	8.6	9.5	8.9	7
AGBM	15.7	38.6	24.6	11	41.8	25.4	9.9	24.8	47.3	38.9	23.8	42.2	34.4	18.3
SYPPl	0.1	0.3	0.2	0.1	0.4	0.3	0.1	0.2	0.4	0.4	0.2	0.4	0.3	0.3
SYPH	0.6	1.8	1.1	0.1	2	1.1	0.5	0.9	2.1	1.6	1.2	2	1.6	0.7
HSW	1	1.5	1.3	0.7	1.8	1.2	0.9	1.2	1.7	1.5	1.3	1.5	1.4	1
rAUDPC	29.3	56.2	44.3	7.2	59.9	41.7	9.5	31.9	69.9	40.9	43.7	55.6	47.3	48.1
Disease reaction class	MS to S			R to S			R	MS to HS			S			S

DE= Days of emergence, DF= Days to 50% flowering, DM=Days to maturity, GFP=Grain filling pried, PL= Pod length, NPBPP= number of primary branch, NSBPP= Number of secondary branch, NNPPl =Number of nodes per plant, NPPPl= Number of pods per plant,AGBM=Above ground Biomass, N SPPL=Number of seeds per plant, NSPP=Number of seeds per pod, SYPH= Seed yield per hector, HSW=Hundred seeds weight in gram, SYPPL=Seed yield in g per plant, AUDPC=Area under disease progress curve.

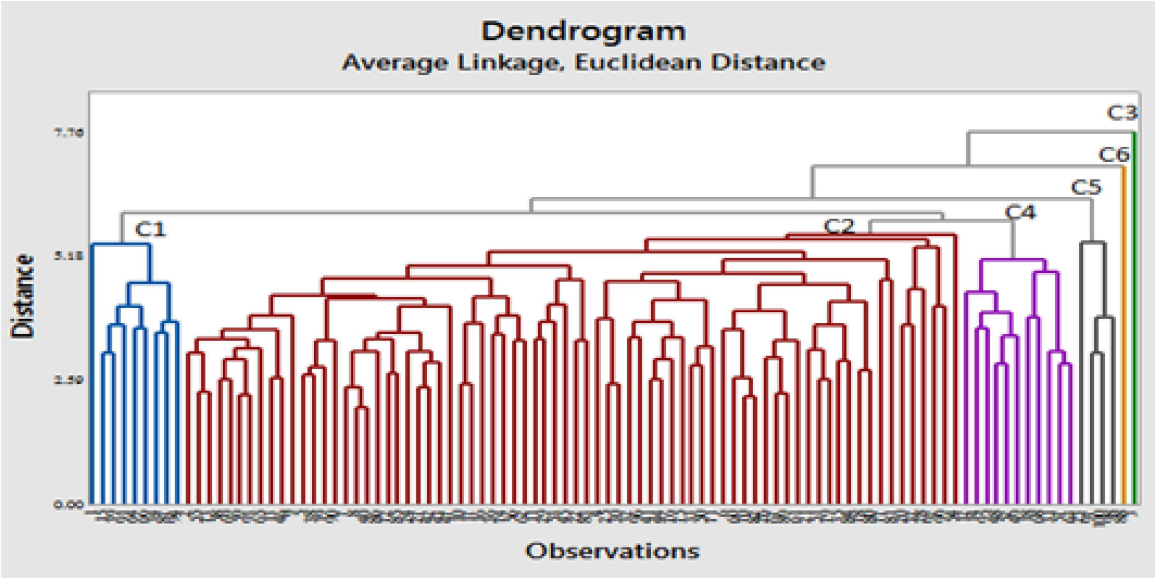

Figure2: Figurative indicators of Dendrogram Average linkage, Euclidean Distance between six clustering of 100 Fenugreek Genotypes

Conclusion and recommendation

Fenugreek (*Trigonella foenum-graecum L.*) is one of the most important seed spice crops in Ethiopia. West showa zone Ambo district is among the major fenugreek producing areas in Ethiopia. Despite its importance, this crop is low yielding due to multiple biotic and abiotic factors. Powdery mildew caused by Erysiphe polygoni is the most economically important disease of the crop in this area. The result of the current study reveals the disease is prevalent with high incidence and severity on susceptible genotypes. According to the result of the current study two fenugreek genotypes viz. 31088 and 237983 show resistant reaction which could cross with 35190 and 31087 which are relatively high yielder. The two resistant accessions also have intermediate performance in their agronomic response and so can be used for development of powdery mildew resistant fenugreek genotypes without fear of losing agronomic performance. Thus, those materials viz. 31088 and 237983 found resistant to powdery mildew disease can be used as germplasm to broaden the genetic base of fenugreek for sustainable production in the country. However, further evaluation of the materials under optimum disease pressure including evaluation of the materials under greenhouse condition is needed.

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Conflicts of interest

The authors declare no conflicts of interest regarding the publication of this paper.

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RESEARCH PAPER

Assessment of the Challenges and Opportunities of Horticultural Crops Production in South-West Shewa Zone of Oromia, Ethiopia

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Abstract

Assessment of the challenges and opportunities of horticultural crop production is essential to identify the constraints and opportunities at a preliminary step in the course of crop productivity improvement goals. In this regard, horticultural crops are highly productive relative to the field crops, and also these crops are better rich in nutrition which is vital in balancing diet for health. Based on the inquiry raised from the society as a core, this study was initiated to identify the challenges and opportunities, which helps to prioritize to locate a noticeable baseline for future intervention. Both primary, as well as secondary quantitative and qualitative data sources, were collected from potential horticulture crop-producing districts of the South-West Shewa zone. These data were analyzed by adopting SPSS software. Descriptive statistics viz., means, standard deviations, frequencies and SWOT analysis were conducted. According to this survey, if the constraining challenges (lack of money; diseases, drought, frost and insects, weather conditions; lack of market; transportation and storage house problems; and limited know-how and skill) were solved, these districts would be potential for producing horticultural crops. Besides the conducive agro-ecology and other endowments, the presence of ample labor, market options, the high interest of the farmers, etc. were great opportunities for the horticultural crop diversification and intensification in the study area. To exploit these potentials, there is a need for farmers and experts to build capacity via training, financial support, provision and adoption of recent technologies (for example improved seeds), credit facilities, and market options, crop management practices.

Keywords: Constraints, potentials, identification, crops

Introduction

Identification of constraints and opportunities is the initial and essential step in development processes aiming at the improvement of crop productivity (Kraaijvanger *et al*., 2016). These investigators elaborated that intervention work that intends to raise agricultural productivity in low-external input settings requires an understanding of farmers' preferences and motivations and the complex socio-cultural settings in which these farmers operate. Agriculture is the mainstay of the economy in Ethiopia, where about 84 percent of the country's population living in rural areas engaged in various agricultural activities and generate income for their household consumption to sustain their livelihood (CSA, 2015; MoANR and MoLF, 2017). It plays a prime role in a country's political, economic and social stability (CSA, 2018). As a consequence of the alarming population growth and the emerging various levels of industries in Ethiopia, there is a need to boost production and productivity in this sector. The study conducted by Diriba *et al*. (2020) indicated the importance of this kind of investigation.

Horticultural crops are highly productive per unit land and time compared to field crops. Also, these crops are regarded as food and

nutritional security crops which is essential in balancing diet for health; i.e., it could have direct or indirect relation toward physical, mental, social as well as political aspects of security. These crops are significantly contributing to food security to feed the increasing population through increasing production and productivity. These crops save foreign currency through reducing crop import from abroad. Besides, horticultural crops play the lion share in Ethiopian economy via their contribution to foreign currency which is about 42 percent to the country's GDP (CSA, 2015; CSA, 2022). The sector unquestionably contributes to the current agriculture-led policy of Ethiopia in realizing the need for agricultural products as raw input for the industries.

The study districts such as Elu, Waliso and Wanchi are largely found in suitable agro climates for the production of horticultural crops including enset which is one of the dominant crops; and it is the major enset growing districts in these zones (ERA, 2012; Ashenafi *et al*., 2016; Ashenafi *et al*., 2017). Assessment of the challenges and opportunities of horticultural crops production in south-west and west Shawa zones of Oromia, Ethiopia can ensure a high chance of success. This should be done from the grassroots most preferably through farmers' participatory method (e.g. survey) of problem identification. Hence, for its realization, it is fundamental to identify the potentials and constraints, and then prioritize them. In the study areas, there was no up-to-date documented information with reference to the potential and constraints related to horticultural crop production. This will certainly lay a baseline for intervention by all the concerned bodies such as governmental, non-governmental organizations (NGOs) and any individual stakeholders. Besides, the result will guide the researchers towards the inquiry of the society/farmers around the studied area to extend the investigation. Hence, based on the inquisition rose from the society as a core, this study was aimed at identifying and prioritizing the production constraints and opportunities of the study area to formulate further research questions for future intervention.

Materials and methods

Description of Study Areas

The study was conducted in the Southwest Shewa zone during 2021/2022. South-west Shewa zone is located at 8º16´-9o56´ N latitude and 37º05´-38º46´ E longitude and altitude ranging from 1600-3576 m.a.s.l. It receives annual rainfall ranging from 900 - 1900 mm. The mean minimum and maximum air temperature of the area is 10ºC and 35°C, respectively (Hailu et al., 2015; Alemayehu, 2016).

Types of data, source and collection methods

The focus of the study was on farm-level data collection and analysis including qualitative and quantitative data on the socioeconomic structure of households and farms, production practices (agronomic practices), and technical production problems. In consideration of the characteristics of the target areas, both quantitative and qualitative open-ended and close-ended questions were used to gather data from the farmers. Also, secondary data were collected from zonal and district agricultural offices.

For qualitative data generation, a Participatory Rural Appraisal (PRA) method was employed in order to utilize the knowledge and opinions of rural people as reference data for future planning. PRA, a qualitative survey methodology, is a process to generate genuine interdisciplinary in the formulation of problems for agricultural research and development (Ison and Ampt, 1992; Belay *et al*., 2013). Hence, focus group discussions (FGD) having 6-12 members were used to identify and clarify shared knowledge among groups of individuals in the communities, which would otherwise be difficult to obtain accurately with a series of individual interviews alone. Similarly, mini-focus groups composed of 4 or 5 members were also used instead in some areas.

Before conducting the survey a preliminary visit to the selected community was made to

obtain background information on the farming system which considered the components of the farm household for instance soil, water, crops, livestock, labor, capital, and other resources. Direct observation and transect walking with the community key informant farmers on crop farms and homesteads were made to have an overview of the topography, vegetation, soil type, crops grown, and water supplies. After transect walking, the collection of data was conducted through Focus Group Discussions (FGD) and with key informant interviews consisting of men and women to discuss extensively the problems and opportunities in their localities. Accordingly, the gathered information was used to rank the perceived constraints based on the severity and importance of constraints to horticultural crop production and postharvest management.

Sampling techniques and sample size determination

Relatively potential horticultural crop-producing districts from the southwest Shewa zone were selected in consultation with the zonal agriculture offices through the preliminary survey. Out of 11 districts found in the southwest Shewa zone, data were collected from purposively selected three districts such as Elu, Waliso and Wanchi. These districts consist of a total of 15, 35 and 23 rural kebeles, respectively. Similar to district choice from the zone, two kebeles were purposively selected from each district for collecting quantitative data surveying through simple random sampling. Accordingly, upon determining a sample size of 20 from each kebele and a total of 120 representative households from districts were used for data collection; it was determined according to Yamane (1967) formula to calculate the total sample size (n) for households; and it was proportionally calculated for each kebele. Further, for reliable qualitative data, in particular, key informants having better knowledge and experience were also included.

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

Where n = designates the sample size the research uses;
N = designates the total number of households;
e = designates maximum variability or margin of error 5%;
1 = designates the probability of the event occurring.

Data analysis

After summarizing data, SPSS software Version 20.0 (IBM Corp., 2011) was used for the analysis process. Descriptive statistics (means, standard deviations, and frequencies) were also applied to analyze. SWOT (strength, weakness, opportunity, threat) analysis was also used to analyze the challenges and opportunities intimately connected to the horticultural crop production aspects.

Results and discussions

The results of the study have been presented and discussed independently in the subsequent sections based on the aim of the study connected to horticultural crop production.

Demographic and socioeconomic characteristics of sample households

Different key variables were used to describe the demographic and socioeconomic characteristics of sample producers. These include family size, age, education level, marital status and gender of the household that can usually influence horticultural crop production. The result of the study demonstrates that the means of family size, age and educational level respectively were 4.392, 43.567 and 6.79. Similarly, minimum and maximum in that order were (2, 22 and 0) and (8, 69 and 13) as indicated below. Regarding marital status and gender of the families, 90.83% are married and 7.5% are not married, and only 1.67% divorced. From this, most of the respondents have gender diversity, 94.17% are male, so females make up only 5.83% of them (Table 1).

Owing to the family size and gender diversity, the need for agricultural activities is not a critical problem for the majority of the farmers.

Nevertheless, daily labor might be required during planting and pick time of harvesting. Moreover, most of them are of productive age and with good education levels.

Table 1. Demographic characteristics of respondents

Continuous variable					
	N	Minimum	Maximum	Mean	Std. Deviation
Family size	120	2.0	8.0	4.392	1.5301
Age	120	22.0	69.0	43.567	9.7634
Educational level	120	0	13	6.79	3.355
Valid N (listwise)	120				

Categorical variable									
Marital status and sex of respondent		District						Total	
		Elu		Waliso		Wanchi			
		No	%	No	%	No	%	No	%
Marital status	Married	34	85	38	95	37	92.5	109	90.83
	Unmarried	6	15	1	2.5	2	5	9	7.50
	Divorced	0	0	1	2.5	1	2.5	2	1.67
Sex of respondent	Male	37	92.5	38	95	38	95	113	94.17
	Female	3	7.5	2	5	2	5	7	5.83

Note: No=sample size; Source: survey result (2021/2022)

Horticulture crops production and supply to the market

In the study areas, the types of crops produced include vegetables, cereals, pulses, coffee, fruits, spices and medicinal/aromatic plants. From these crops, fruits such as avocado, banana, papaya, mango, apple and orange; and among vegetables including root and tuber crops like onion, cabbage, tomato, potato, beetroot, inset, carrot, hot pepper and garlic (Table 2) are produced in their ascending order in terms of volume of production. A similar result on the type of horticultural crops produced in the areas was obtained according to a study conducted by Ajabush *et al*. (2020).

There is an important point that has to be noted about the rank of enset production indicated as five (5) in the table, particularly under Wanchi district. Wanchi area is a potential area for enset crop production and consumption as well. But the kebeles selected for the sake of studying different horticultural crops including enset may or may not be producing enset. In addition to this, the selected households of those kebeles may not be producing it. Otherwise, the crop is widely available and very well cultivated in Wanchi district similar to Waliso district. In line with this study, according to Alemayehu (2016), the major horticultural crops produced in the area include enset, potato, tomato, cabbage, beet, root, onion, garlic, apple, mango, avocado and banana. Hence, similarly, there might be minor misleading general results happening on other crops too which could be true for any research topic. Most respondents (about 79 %) replied that they were selling most of their produce (50-75%); similarly, about 78 % of the respondents said, only a small sum (0-25%) for

home consumption (Table 3). Collectively, more than 50 % of their produce was usually provided for sale. This result is contrary to the national data of CSA (2021) stating that about 70-80 percent was utilized for home consumption. The survey result may indicate the tendency towards business-minded circumstances of the farmers in the study areas. Hence, the trend is encouraging due to the fact that farmers tend to produce more and diversify horticultural crops since they intend to produce for sale instead of home consumption only.

Table 2. Type of fruit, vegetable, root and tuber crops produce during 2020/2021

Fruit crops										
Type of crops		Districts						Total		Rank
		Elu		Waliso		Wanchi				
		No	%	No	%	No	%	No	%	
Avacado	No	40	100	24	60	7	17.5	71	59.17	
	Yes	0	0	16	40	33	82.5	49	40.83	1
Papaya	No	40	100	39	97.5	24	60	103	85.83	
	Yes	0	0	1	2.5	16	40	17	14.17	3
Banana	No	40	100	39	97.5	2	5	81	67.50	
	Yes	0	0	1	2.5	37	95	38	32.50	2
Mango	No	40	100	33	82.5	36	90	109	90.83	
	Yes	0	0	7	17.5	4	10	11	9.17	4
Apple	No	40	100	40	100	36	90	116	96.67	
	Yes	0	0	0	0	4	10	4	3.33	5
Orange	No	40	100	39	97.5	38	95	117	97.50	
	Yes	0	0	1	2.5	2	5	3	2.50	6
Vegetable, root and tuber crops										
Type of crops		Districts						Total		Rank
		Elu		Waliso		Wanchi				
		No	%	No	%	No	%	No	%	
Tomato	No	10	25	26	65	22	55	58	48.33	
	Yes	30	75	14	35	18	45	62	51.67	3
Hot pepper	No	29	72.5	39	97.5	26	65	94	78.33	
	Yes	11	27.5	1	2.5	14	35	26	21.67	7
Cabbage	No	15	37.5	12	30	21	52.5	48	40	
	Yes	25	62.5	28	70	19	47.5	72	60	2
Onion	No	6	15	13	32.5	8	20	27	22.50	
	Yes	34	85	27	67.5	32	80	93	77.50	1
Garlic	No	40	100	38	95	30	75	108	90	
	Yes	0	0	2	5	10	25	12	10	8
Carrot	No	40	100	21	52.5	31	77.5	92	76.67	
	Yes	0	0	19	47.5	9	22.5	28	23.33	6
Beetroot	No	40	100	19	47.5	22	55	81	67.50	
	Yes	0	0	21	52.5	18	45	39	32.50	5
Potato	No	40	100	4	10	20	50	64	53.33	
	Yes	0	0	36	90	20	50	56	46.67	4
Enset	No	40	100	1	2.5	40	100	81	67.50	
	Yes	0	0	39	97.5	0	0	39	32.50	5

Note: No=sample size; Source: survey result (2021/2022)

Table 3. Average yield (%) of horticultural crops production for consumption and sell

Amount (%) of produce for home consumption and sale		District						Total	
		Elu		Waliso		Wanchi			
		No	%	No	%	No	%	No	%
Amount (%) of produce for home consumption	0-25%	40	100	14	35	40	100	94	78.33
	25-50%	0	0	22	55	0	0	22	18.33
	50-75%	0	0	4	10	0	0	4	3.33
	100%	0	0	0	0	0	0	0	0
Amount (%) of produce for sell	0-25%	0	0	2	5	0	0	2	1.67
	25-50%	0	0	23	57.5	0	0	23	19.17
	50-75%	40	100	15	37.5	40	100	95	79.17
	100%	0	0	0	0	0	0	0	0

Note: No=sample size; Source: survey result (2021/2022)

Different inputs used for horticultural crop production

In this study, some of the inputs (Table 4) such as seed, fertilizer and insecticide which were used for horticultural crop production were also assessed. Accordingly, 48.33 of the respondents were using improved seed followed by 37.5% local seed and 14.17 % using both. The use of improved seed could have been increased if the farmers were able to get reliable quality seed. Because some traders were providing mixed and poor-quality seeds, farmers were forced to use their own seeds since there was no alternative quality seed supplier.

Most of the respondents (94.17%) were applying insecticides while only a few (5.83) of them were not. They were not applying which might be due to two reasons. The first one that needs attention is no awareness or knowledge of the farmers about the significant loss of crop yield by insect damage. On the other hand, there might be tangible but insignificant insect damage on their crops.

The types of fertilizers used in the area were both organic (compost, manure) and inorganic (urea, blended NPS) as stated in Table 4. From organic fertilizer, the majority (50.83%) of the respondents were applying cattle manure; whereas compost was 25.83% and those using both were 8.33%. Concerning inorganic fertilizer, most of the respondent farmers (96.67%) were applying both blended and urea; hence there were also farmers only using urea for their crop production by realizing that it increases vegetative growth but without considering the better yield advantage while using other fertilizers (e.g. NPS). On the other hand, there were a few farmers (0.83%) responding that were not applying inorganic fertilizers realizing that the organic fertilizers, particularly cattle manure which can easily be obtained from their own homes were sufficient. Farmers added also, they cannot afford inorganic fertilizer which is in line with the result revealed by Alemayehu (2016) stating that farmers prefer organic fertilizer due to its lower price as compared to inorganic fertilizer.

Table 4. Farmers adopting (%) inputs for horticultural crop production in 2020/2021

Inputs used		Districts						Total	
		Elu		Waliso		Wanchi			
		No	%	No	%	No	%	No	%
Type of seed used	Improved	15	37.5	9	22.5	34	85	58	48.33
	Local	24	60	15	37.5	6	15	45	37.5
	Both	1	2.5	16	40	0	0	17	14.17
Type of fertilizer used	Organic	0	0	0	0	0	0	0	0
	Inorganic	22	55	2	5	3	7.5	27	22.5
	Both	18	45	38	95	37	92.5	93	77.6
Using of insecticides	Not used	1	2.5	0	0	6	15	7	5.83
	Used	39	97.5	40	100	34	85	113	94.17
Type of organic and inorganic fertilizers utilized (%)									
Types of fertilizers		Districts						Total	
		Elu		Waliso		Wanchi			
		No	%	No	%	No	%	No	%
Organic fertilizer in %	Compost	12	30	0	0	19	47.5	31	25.83
	Manure	13	32.5	28	70	20	50	61	50.83
	Both	0	0	10	25	0	0	10	8.33
	None	15	37.5	2	5	1	2.5	18	15
Inorganic fertilizer in %	Blended	0	0	0	0	0	0	0	0
	Urea	1	2.5	0	0	2	5	3	2.50
	Both	39	97.5	40	100	37	92.5	116	96.67
	None	0	0	0	0	1	2.5	1	0.83

Note: No=sample size; Source: survey result (2021/202)

Types of services and their sources

Different services are required by the farmers for crop production and other related activities across the whole value chain including postharvest till the produce reaches the end users. Those services such as access to credit for financial security, extension activities, reliable and timely marketing information, and training on different aspects from production to the end are the main important points to be considered by all the concerned parties. As results shown in Table 5 below, credit access was the least (30%) while extension (96.67%) was the most of all the services obtained; followed by training (73.33%) and market information (90%) accesses relative to credit. The most important factor related to the problem of credit as replied by the farmers was the high interest rate above and beyond lack of access. However, farmers have an interest in borrowing to fulfill inputs required for production and other related farming activities. A similar problem regarding the high interest rate of credit was identified by different scholars in other areas within this region (Mosisa, 2018; Diriba *et al*., 2020; Tadesse *et al*., 2021).

Table 5. Access to different services by sample respondents within three districts

Services and access		Districts						Total	
		Elu		Waliso		Wanchi			
		No	%	No	%	No	%	No	%
Credit access during the last production seasons	No	20	50	24	60	40	100	84	70
	Yes	20	50	16	40	0	0	36	30
Extension services access to horticultural cultural practices	No	2	5	0	0	2	5	4	3.33
	Yes	38	95	40	100	38	95	116	96.67
Market information access	No	0	0	0	0	12	30	12	10
	Yes	40	100	40	100	28	70	108	90
Training access on agriculture/ horticulture production	No	17	42.5	0	0	15	37.5	32	26.67
	Yes	23	57.5	40	100	25	62.5	88	73.33

Note: No=sample size; Source: survey result (2021/2022)

Production constraints of horticultural crops

There are a lot of constraining factors hindering farmers from boosting their crop production and of course productivity. Among others in their order of importance, lack of money to invest which is the most limiting factor; diseases, drought, frost and insects, weather conditions; lack of market; transportation and storage house problems; and limited knowhow and skill are the important bottleneck for the farmers as the study result is indicating in Table 6. Accordingly, 97.5%, 75%, 54.2%, 53.3% and 62.5%, respectively are the result of the individual farmer face-to-face interviews during the survey. In all the three study districts, the disease problem is very serious, and there is a misuse of chemicals, i.e., using the same chemical (e.g. Malathion) for all crops like onion, tomato, potato and other related vegetables. This is due to the lack of chemicals at the farmers' level; either they cannot afford or different chemicals may not be available and/or accessible at the right time. Similarly, there is confusion about which chemical is used for diseases or insects hence some farmers are applying insecticides for diseases and vice versa.

Access to credit is one of the means to alleviate the shortage of money for any accomplishments related to crop production and other postharvest activities including marketing. But there are ranked problems such as limited supply of credit, huge bureaucracy, high cost of credit, and also limited access to transport to the area at which credit service is available. Hence, 63.3%, 55%, 50% and 30% of the respondents confirmed the problems in their order of magnitude (Table 6). So, farmers' welfare can be tackled if the above-mentioned production, marketing and any other related problems according to their priority can be properly solved. This needs the involvement of different concerned stakeholders besides government sectors.

Table 6. Constraints hindering farmers not to increase their horticultural crop production

No	Type of Constraints		Frequency	Percent	Valid Percent	Cumulative Percent	Rank
1	Lack of money to invest	No	3	2.5	2.5	2.5	1
		Yes	117	97.5	97.5	100	
2	Limited knowhow and skill	No	75	62.5	62.5	62.5	5
		Yes	45	37.5	37.5	100	
3	Lack of market	No	55	45.8	45.8	45.8	3
		Yes	65	54.2	54.2	100	
4	Transportation and storage house problems	No	56	46.7	46.7	46.7	4
		Yes	64	53.3	53.3	100	
5	Diseases, drought, frost and insects, weather condition	No	30	25	25	25	2
		Yes	90	75	75	100	
Constraints of accessing credit service in study areas							
No	Prioritized Constraints		Frequency	Percent	Valid Percent	Cumulative Percent	Rank
1	Huge bureaucracy	No	54	45	45	45	2
		Yes	66	55	55	100	
2	High cost of credit	No	60	50	50	50	3
		Yes	60	50	50	100	
3	Limited supply of credit	No	44	36.7	36.7	36.7	1
		Yes	76	63.3	63.3	100	
4	Limited access to transport	No	84	70	70	70	4
		Yes	36	30	30	100	

Source: survey result (2021/2022)

Production opportunities for horticultural crops

The area is potentially endowed with suitable agro-ecologies be it edaphic (soil factor), climatic, and water for the production of horticultural crops. However, these opportunities have not been utilized corresponding to their potential. For instance, water availability is very prospective but irrigation projects are scarce that hinder the farmers from even producing on their very suitable lands. Generally, the favorability of the area for all horticultural crops is one of the motivating factors in all the study areas. Another important aspect is the availability of abundant of labor for any occupational need. As compared to field crops horticultural crops production requires a high labor force (Dassa *et al*., 2019). Also, the politeness and acceptance of some farmers to exercise full package agricultural activities according to the instruction they were given by experts could be a considerable opportunity. Although on the other hand, most of them were reluctant to implement the packages. Moreover, some NGOs have been supporting agriculture sectors, particularly horticulture. Organizations namely SNV (*Stichting Nederlandse Vrijwilligers* = Foundation of Netherlands Volunteers), Save the Children and World Vision have currently been doing different farmer-supporting activities in the study areas. Probably the other most important note, though on commencement, is that the government's focus on the establishment of fruit crop production in clusters of farmers now is encouraging. Generally, the detail is briefly stated as a means of the SWOT analysis under the following headings such as input supply, production, postharvest handling, storage, transportation, marketing and consumption.

Input supply

Strength: The existence of fruit and coffee nurseries in some districts; initiation of some farmers to use improved varieties.

Weakness: Fertilizers are not always accessible to farmers, particularly for irrigation producers; generally, the supply of inputs is unsound; farmers prefer low-cost seed to quality.

Opportunity: Fertilizers are available at primary cooperatives, and farmers can buy in cash; Waliso-Liban union started supplying some vegetable seeds; high demand for the produces at area; some farmers are in the process of producing seeds of a few vegetables (potato and onion); the presence of some government projects, for instance, Agricultural Growth Program (AGP), and NGOs such as World Vision, Save the Children, and Sustainable Land Management (SLM).

Threat: Increasing input price; lack of quality seed; diseases and pests; expensiveness and lack of hybrid seeds; lack of credit; illegitimate traders; unavailability of pesticides at primary cooperatives; absence of loan intended for horticulture crops production.

Production

Strength: Using improved varieties and applying full package practices are increasing; three times (two by irrigation and one by rain-fed) vegetable production; fruit and coffee plantation area is increasing; increasing farmers' skill/knowledge.

Weakness: Most farmers are not using improved varieties and applying full package practice; not all farmers are using inputs and irrigation water properly; farmers do not follow the cropping calendar, crop staggering (resulting in improper simultaneous supply of all the produce to market); poor cost analysis on vegetables.

Opportunity: Favorable agro-ecology for all horticulture crops; some of the farmers are experiencing full package; fruit production cluster focus by the government; NGOs support farmers; plenty of labor.

Threat/constraint: Lack of irrigation water; lack of improved seed and cultivar; production decrease owing to poor quality seed; climate change; vegetable disease.

Consumption

Strength: Consumption (eating) experiences development by some producers; in general, high demand for consumption by society from time to time.

Weakness: Negligence of experiencing consumption by the majority of producers; lack of awareness creation on the importance of nutrition.

Opportunity: Training providing on consumption by home agents of agriculture offices as well as health extension agents; consumption increasing with urban expansion.

Threat/constraint: Unsustainable access and availability of produce.

Suggested key intervention points

Based on this study, the subsequent suggested areas of intervention have been identified for the improvement of horticulture in the study areas. We believe that the direct involvement of different concerned government sectors is very imperative. Besides, these sectors should also play their role in awareness creation, mobilization and participation of others such as private sectors, NGOs, etc in order to practically improve the horticulture sector. This becomes truly implemented if we are able to invest on farmers' capacity-building strategy as well. Accordingly, based on the farmers' realistic suggested points as well as the potentially available natural endowments, the below-mentioned ideas should be considered:

Higher institutions and other similar sectors should support farmers in different intervention areas. Primarily, inputs (e.g. improved seed, fertilizers, chemicals, etc) access and availability for the farmers should be secured at the right time. An additional important issue raised by the farmers is the availability of water such as ground water and river water. In the

same way, the potentiality of enset at Waliso and Wanch districts was attentively raised to get better emphasis.

Groundwater: the farmers at Dasse Jabo kebele in Waliso district had forwarded during the discussion that groundwater is available near the surface. So, the farmers said that they need access to this water and power pump so as to utilize and produce year-round without the risk of water shortage.

River water: similarly, farmers at Kata Asgori kebele in Elu district forwarded the construction of a small dam on the nearby river namely Teji River to alleviate the scarcity of water obtained from this river during the dry season for irrigation production of horticulture crops. They further explained, otherwise this area is not suitable for horticultural crops during the rainy season and hence they instead produce cereal crops in the rainy season. Therefore, if the water scarcity problem in the dry season is tackled, they can produce two or more times on the same land by breaking the usual trend of relying only on the rainy season. In the Elu district on the other hand there is a serious problem of flooding during the rainy season from rivers such as Taji, Awash and Jalliwan which are potentially destroying crops and threatening other properties including houses in some years.

Enset (kocho): it is obviously known that areas embraced under Waliso and Wanchi districts are potentially producing enset as a country. It is a highly potential crop not only as a food crop but also as a cash crop. Even people in the area particularly in Waliso, the capital city of south-west Shewa, are doing a kind of value addition by using plastics as packing material and exporting quality products in this manner. If they are supported in this area, there is a possibility of great improvement in production as well as in exporting through advanced value addition. Based on the data in the area, they said that the crop on average yields about 25 kg per individual plant indicating promising productivity of the crop. However there is a risk of disease collapsing the crop if affected, particularly it is severe on the highlands. Hence there is a strong request and expectation of the farmers as well as the experts of those areas that Ambo University (AU), as a nearby big institution in its thematic area as well, identify the problem through research to solve this devastating recurrent disease in this region. They said that the disease is killing matured or medium-sized plants, i.e., top-down wilting of the affected crops. The opportunity to look for knowledge farmers about disease-resistant, drought tolerant and early maturing landraces is very crucial for genetic improvement through breeding (Borrell *et al*., 2020). On top of this, the farmers added also, there is a supply chain problem regarding marketing from producers (farmers) to the end users or consumers. A similar study output at the areas was reported by Tadesse (2018) indicating that there should be due attention to help farmers benefit a reasonable proportion from the selling of their enset produce.

Research and/or training have been considered to be the essential areas of concern through the following ways of involvement. These are varieties of adaptation or performance assessment research; training on agronomy, protection, handling, and storage methods; development of pest and disease management strategies; detailed market value chain research; training on market and produce quality; and clear awareness towards making people business minded further for the market instead of only producing for home consumption. Soil-related research is another concern because the problem of soil acidity in the zone was also raised. The issue of soil is essential in managing crop nutrition.

The fruit crop propagation issue was also forwarded by the experts during our focus group discussion. As mentioned in Table 2, fruits such as Avocado, Banana, Papaya, Mango, Apple and Orange are produced in the study areas. This can be an indication of the suitability of the location for such major fruit crop production, which is promising for further investment in it. On the other hand, the experts explained that fruits, for instance, apple grafted at other locations even in our country may not be adapting to the study area. So, they suggested that it is better to do grafting in this environment if we are able to coordinate with

the concerned institutions such as Ambo University for professional advantage.

Conclusion and recommendation

In conclusion, the study areas are generally very suitable for different horticultural crop production provided that interventions against these problems are made and all the available resources and potentials (land, agro-ecology, labor, groundwater and river water, and the willingness of the farmer are optimally utilized. According to the survey study the following important recommendations could be forwarded:

Farmers should follow the right agronomic practices given by professional intervention. As explained by the development agents (DAs) in the respective districts, very few farmers are willing to follow the instructions given through extension services. Therefore, there must be training to shape the attitude of farmers towards accepting new technologies and interventions (e.g. continuous field demonstration).

Farmers should use improved seeds with full packages as much as possible. Farmers should also be aware of insecticides and must not use them for disease control and vice versa.

All stakeholders such as the government, NGOs, and any concerned individuals and/or professionals should seriously contact farmers to understand their needs and always support them. This might include financial, professional, material, and any other support required for the farm community.

There should be sufficient access to financial institutions giving credit relatively with the lowest interest rate. In the study areas, though accessibility is not a serious case, the problem of high interest rates has been prohibiting farmers from using the available credit advantage. A promising trend has currently been started to support horticultural crop producers for instance SNV, a not-for-profit international development organization, can be a good example.

There should be low-interest rate financial sources established solely intended for encouraging the horticulture sector across the whole value chain.

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Conflict of interest

The authors have no any conflict of interest..

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RESEARCH PAPER

Determinants of private investment in the manufacturing sector of Ethiopia: Evidence from Ambo town, Oromia regional state

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Abstract

Ethiopia has recently implemented policies aimed at rebalancing the roles of the public and private sectors in the economy, with a particular focus on developing the private sector. Private manufacturing investment is crucial for both local and national economic growth. However, private investment in Ethiopia faces several significant challenges. This paper examines the determinants of private investment in the manufacturing sector specifically in Ambo town. Using cross-sectional data collected from 266 randomly selected private investors and workers in private firms, this study employs descriptive and econometric analyses, utilizing the Ordinary Least Squares (OLS) regression model in STATA software version 12. Descriptive analysis is used to characterize the socioeconomic and demographic profiles of respondents, while the OLS regression identifies significant determinants of private manufacturing investment. The results indicate that education level, and land size, have significant effects on manufacturing private investment at 5% significance levels. The findings reveal that both education level and land size significantly influence private investment decisions in the manufacturing sector of Ethiopia. Higher levels of education among investors are associated with increased private investment in manufacturing. Education equips investors with the necessary skills and knowledge to navigate the complexities of the manufacturing sector, thereby enhancing their confidence and willingness to invest. Furthermore, access to land plays a critical role in attracting private investment in manufacturing. Investors with larger land holdings are more likely to allocate resources towards establishing or expanding manufacturing facilities, benefiting from economies of scale and operational efficiencies. The study concludes that these determinants of private manufacturing investment have varying impacts on the local economy and provide a foundation for further research in this area.

Keywords: Determinants, private manufacturing investment, multiple linear regression models

Introduction

Private investment plays a pivotal role in fostering economic growth, driving innovation, and creating employment opportunities, particularly in developing countries like Ethiopia. The manufacturing sector, in particular, serves as a key engine of economic development by transforming raw materials into value-added products, enhancing productivity, and promoting industrialization (World Bank, 2019).

Ethiopia, Africa's second-most populous country, has prioritized industrialization as a central pillar of its economic development strategy (FDRE, 2010). With a burgeoning population and abundant natural resources, Ethiopia offers significant potential for private investment in the manufacturing sector (World Bank, 2020). However, despite the government's efforts to attract investment through various policy initiatives and incentives (Aragie and Bulte, 2019), private investment in manufacturing remains below its full potential.

Understanding the determinants of private investment in the manufacturing sector is critical for policymakers, investors, and development practitioners seeking to promote sustainable economic growth and industrialization in Ethiopia. Ambo Town, located in the Oromia region, represents a microcosm of Ethiopia's manufacturing landscape, offering valuable insights into the factors influencing private investment decisions at the local level.

Investment is widely acknowledged as a crucial element in economic development and poverty alleviation efforts (Wolfenson, 2007). Private investment, a significant subset of overall investment, plays a vital role in fostering economic growth and improving living standards (Bayai and Nyangara, 2013). It is recognized globally as a primary driver of economic growth, contributing to capital formation and sustainable growth rates (UNCTAD, 2008). Private investment, particularly in manufacturing, enhances a nation's production capacity and long-term economic prospects (Frimpong & Marbuah, 2010).

In many developing countries, including Fiji, Ghana, and Pakistan, private investment has been instrumental in addressing economic challenges such as poverty and unemployment (Bayai and Nyangara, 2013). Although Africa's manufacturing sector has faced challenges, it is seen as a potential engine of growth due to its capacity to create skilled jobs and modernize economies (Bigsten and Soderbom, 2006).

Ethiopia has long recognized the importance of industrialization for economic development, with initiatives dating back to the 1940s (UNDP, 2016). Despite past efforts, private investment in manufacturing has not met expectations, prompting the government to prioritize private sector development (MoFED, 2014). While private investment in Ethiopia has increased in recent years, it remains below levels seen in other sub-Saharan African countries.

Private investment is crucial for long-term economic growth in Ethiopia (Adugna, 2013). However, it has exhibited fluctuating trends, even following economic reforms in 1996 (Alemayehu, 2004). Low investment levels not only impede economic growth but also increase the economy's vulnerability (Oshikoya, 2001). Challenges such as a lack of awareness among investors about modern business practices hinder private sector growth (Adugna, 2013).

Empirical studies have examined various factors influencing private investment in manufacturing sectors globally (PIMS) (Frimpong and Marbuah, 2010). However, research on Ethiopia's private investment determinants is limited by time constraints and changes in investment laws (Woldemeskel, 2008). Despite government support, many approved investment projects remain unrealized, particularly in the manufacturing sector.

The current study addresses gaps in understanding the determinants of private investment in manufacturing sectors in Ethiopia, specifically in Ambo, Oromia. While private investments in manufacturing contribute to economic growth and poverty reduction, they face challenges in transitioning to larger enterprises (Haile and Assefa, 2005). Identifying these challenges is essential for policymakers to formulate effective strategies to support private sector growth (Bigsten and Gebreeyesus, 2009).

Despite the growing interest in private investment and industrialization in Ethiopia, there is a dearth of empirical research examining the specific determinants driving private investment in the manufacturing sector, particularly at the subnational level (Tefera and Seid, 2019). Existing studies have largely focused on macro-level analyses or have been limited to specific industries or regions, overlooking the nuanced dynamics shaping investment decisions in local contexts (Aragie and Bulte, 2019).

By focusing on Ambo Town, this study seeks to fill this gap in the literature by providing empirical evidence on the determinants of private investment in the manufacturing sector at the local level. By examining factors such as

education level and land size, which have been identified as significant determinants of private investment in previous studies (Tefera & Seid, 2019; Asiedu, 2002), this research aims to contribute to a deeper understanding of the drivers of investment decisions among local entrepreneurs and investors in Ethiopia.

Materials and methods

Study Area

Ambo town, situated in the western part of the Oromia regional state, serves as the administrative hub of the East Shewa Zone in Ethiopia. Established in 1889, it spans an area of 8,587 hectares, making it one of Ethiopia's oldest urban centers. The name "Ambo" is linked to its progenitor, "Ambo Tseble" (Ambo Town Municipality, 2010).

During the reign of Haile Selassie, the town was renamed Hager Hiwot, only to revert to its original name in 1974 under the Dergue regime. Historically, Ambo has enjoyed prominence, evident from the substantial administrative infrastructure and the formulation of a master plan in 1931. Its strategic position has solidified its status as a pivotal center for administration, transportation, and commerce in the West Shewa Zone. With expansion underway, the town now encompasses additional kebeles, such as Awwaro and Illamu Muja, towards the east (Ambo Town Municipality, 2010).

Geographical Location

Ambo town is situated at 08°59'N latitude and 37°51'E longitude, with an average elevation of 2,090 meters above sea level, fluctuating between 2,060 to 2,140 meters. The region experiences an average annual precipitation of 912 millimeters and maintains a mean annual temperature of approximately 17.6 degrees Celsius. Serving as the administrative capital for the West Shewa Zone, Ambo town adheres to a comprehensive township plan devised by the national planning institution. This master plan encompasses various facets, including development initiatives, road networks, drainage systems, and land utilization strategies (Ambo Town Municipality, 2021).

Sampling procedures and method of data collection

To calculate the sample size using the Yamane formula, we'll use the following information:

- Total population size N=788 (total number of investors in the manufacturing sector).

- Desired level of precision (e): This is not explicitly provided, but typically it's predetermined based on the researcher's preference or standard practice. Let's assume a precision of 5%, So (e = 0.05).

Now, we'll use the Yamane formula:

n = N / (1 + N (e^2))

Where:

- n is the desired sample size
- N is the size of the population
- e is the desired level of precision or margin of error (expressed as a decimal) Substituting the given values:

788/ (1 + 788 \times (0.05) ^2)

788/ (1 + 788 \times 0.0025)

788/ (1 + 1.97)

788/ (2.97)

n ≈ 265.32

Since, we can't have a fraction of a person in our sample, we round up to the nearest whole number. Therefore, the sample size (\(n \)) using the Yamane formula is approximately 266.

Stratified Random Sampling Technique

Since the population is heterogeneous (different sub-sectors), using stratified random sampling is appropriate. This technique ensures that each sub-sector is adequately represented in the sample, leading to more precise estimates for each subgroup. In this case, the proportion of investors in each sub-sector is used to determine the sample size for each stratum, ensuring proportional representation in the final sample.

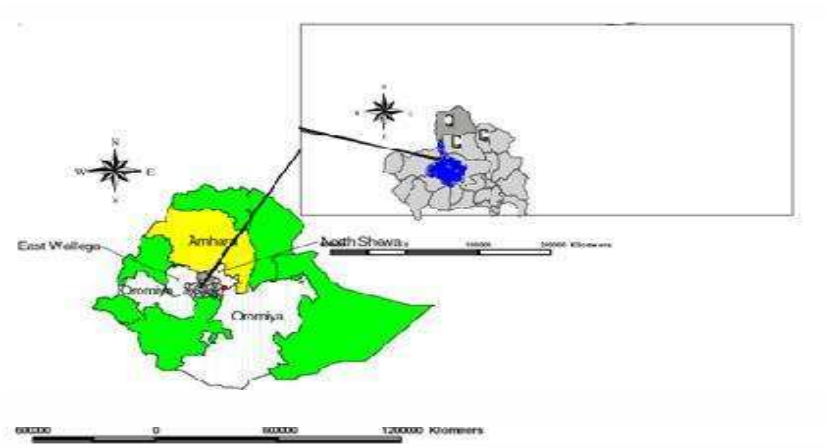

Figure 1. The map of the study area.

Data Analysis Method

This study employed a mixed-methods approach, incorporating both qualitative and quantitative data to address the research inquiries comprehensively. Qualitative data were gathered through a qualitative methodology, while quantitative data, earmarked for statistical scrutiny, were amassed using quantitative techniques. The determination of the sample size was facilitated by the Yamane Taro Formula of 1967, ensuring a representative sample from the heterogeneous population. Employing a Stratified Random Sampling technique, the private investment landscape within the manufacturing sector was categorized into seven distinct sectors.

A total of 266 investors were randomly selected from the 788 investors constituting the population, forming the sample pool for primary data collection and information gathering. To ensure robustness and reliability, pre-tested and semi-structured interview questionnaires were deployed, designed following a pilot survey conducted within the study area and incorporating feedback from investors. Primary data were meticulously collected through face-to-face interviews with investors.

The validity and reliability of the collected data and information were fortified through triangulation, where findings were cross-examined and corroborated through focus group discussions with key informants, employing comprehensive checklists. This methodological approach upheld the rigor and integrity of the research, enhancing the credibility and trustworthiness of the study outcomes.

Table 1. Expected Signs of Variables

Econometric model specification

Multiple linear regression models were employed to analyze the multifaceted interplay of demographic, socioeconomic, and environmental factors influencing private investment in the manufacturing sector at the micro level. This model was chosen for its effectiveness in identifying the determinants of private manufacturing investment.

The model equation can be expressed as follows:

$$Y = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots + \beta_k X_{ki} + \varepsilon i$$

Where:

Y = Quantity of private investment made by investors.
β = (Beta) Estimated coefficient of explanatory variables.
X = Vector of explanatory variables.
εi = Error term.

Variable	Short name	Expected sign	Measurement and types of variables
Private Invested in manufacturing	Pim	Dependent variable	Continuous (in capital)
Education level of the investor	Edu	+	Continuous (in years of schooling)
Loan given by bank in the last 10 years	Loan	+	Continuous (in monetary terms)
Average power blackout in weeks per hour	Blackout	+	continuous (number of powers off outages per weeks)
Total area of the firm	Area	+	Continuous (Measured in
Interest rate	intr	–	Categorical (1=high,0 otherwise)

Definition of Variables and Hypotheses

In exploring the factors influencing private investment in the manufacturing sector, the study undertook the task of identifying potential influencers and delineating their directional relationships with the dependent variable. Determinants of private investment in manufacturing were derived from a review of related literature and the study's datasets. Subsequently, five explanatory variables were selected for model estimation and defined as follows:

Dependent Variable

Private Investment: Represents the amount of capital held by investors and is measured in terms of capital.

Independent Variables

Education Level: This continuous variable indicates the formal schooling attained by respondents during the survey period, measured by the years of education gained. It is expected to positively impact investment in the manufacturing sector due to the sector's technological demands and perceived riskiness, which educated investors are better equipped to manage.

Loan: As manufacturing sectors typically require substantial financing, access to finance is crucial. The frequency of loans granted by banks to investors in the last decade serves as a proxy for access to finance. This variable is anticipated to positively correlate with investment in manufacturing, as better financial access tends to attract investors to sectors with higher profit margins, such as manufacturing.

Electricity: Reliable access to electricity is essential for manufacturing investments. The variable "blackout" quantifies average power outages per week for a random firm and is expected to have a positive coefficient, indicating that higher power outages deter investors from the manufacturing sector.

Land: Access to land is a significant constraint for investors, particularly in the manufacturing sector. The variable "area" measures the total area of a firm's production plant or storage facilities and is expected to have a positive relationship with investment in manufacturing, as increased provision of land enhances the probability of investment.

Interest Rate: Interest rates play a pivotal role in economic decisions, influencing saving and investment behaviors. A lower interest rate incentivizes borrowing for investments. Thus, private investment is negatively related to the interest rate, with lower rates stimulating investment.

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Results and Discussion

Socio-demographic characteristics of sample households

This section presents the descriptive analysis of the survey conducted to assess the determinants of private investment in the manufacturing sector in Ambo town. Although the introduction stated that 266 samples were used, it's now clarified that the sample size is 266. Respondents were interviewed about their personal information, including age, gender, marital status, and education level, to understand their demographic profile and its implications on investment behavior.

Gender Distribution

Among the total respondents, 62 (68.8%) were male investors, while 28 (31.2%) were female investors. This gender disparity suggests that males currently dominate investment activities in Ambo town, although females also play a significant role. It is anticipated that female participation in investment will continue to rise, contributing to a more egalitarian society.

Marital Status

Regarding marital status, the majority of respondents were single (43.3%), followed by married (37.7%), divorced (14.4%), and widowed (4.4%). The data indicates that

married individuals constitute a significant portion of active investors, comprising over 39% of the total respondents.

Table 2. Marital Status of Respondents

Marital	Frequency	Percentage (%)
Married	100	37.59%
Single	82	30.82%
Divorced	55	20.67%
Widowed	29	10.9%
Total	266	100%

Source: Own survey in Ambo, 2024

Table 3. Age Distribution

Age	Frequency	Percentage (%)
18-30	122	45.86%
30-45	83	31.2%
>45	61	22.9%
Total	266	100%

Source: Own survey in Ambo, 2024

The age distribution of respondents is relatively evenly distributed across different age groups. The 18-30 and 30-45 age groups constitute the majority, comprising approximately 43.3% and 42.2% of the total sample, respectively.

Result of MLRM

Multiple linear regression results of determinants of private investment in the manufacturing sector

Variables	Coefficient	Std .err	t	p>/-Z/
Education	.123899	.0147201	8.42	0.000***
Area of land	.1549544	.0265822	5.83	0.000***
Loan	.2856952	.1036395	32.76	0.007***
Blackout	.1029821	.1194309	0.86	0.390
Interest rate	-669.4683	7096.231	- 0.09	0.92
Cons	6.54211	1.151892	5.68	0.000

Note: The dependent variable -is private investment in the manufacturing sector. *** at 1% SL.
The regression result shows that education and area of land are statistically significant at a 5%, level respectively.
Number of obs = 266 Prob > F = 0.0000
R-squared = 0.4814, Adj R-squared = 0.4686
Source: Authors' computation using MLR (2024)

The regression result showed that the coefficient of education of investors was positively related to the investment. When the education of investors increases in years of schooling, the investment also increases, while other things remain constant. It is also significant at a 5% level of significance. Both tertiary and primary level of education is positively associated with private investment. However, the coefficient of tertiary level of education is significant implying that a higher level of education increases the ability to invest in different private investment of manufacturing sectors in the local economy.

According to the regression result, the loan affects the investment positively. This means that increasing the loan for investors also leads to an increase in the investment in manufacturing sectors actively, while other things remain unchanged. As regression result implied that the blackout of electricity has positively related to investment in the manufacturing sector. When the blackout of electricity increases the investment in the manufacturing sector also increases, while other variables remain unchanged. Generally, the result shows that electricity is highly correlated with investment in the manufacturing sector.

The result of regression shows that the area is also positively related to the investment in the manufacturing sector. As a better land size is available for the investors the investment opportunity also increases, while the other things are constant. According to the result of the regression, the interest rate is affected negatively, and it is insignificant. That means an increasing interest rate in investment leads to decreases in private investment in the manufacturing sector, while other factors remain constant.

The findings reveal that both education level and land size significantly influence private investment decisions in the manufacturing sector of Ethiopia. Higher levels of education among investors are associated with increased private investment in manufacturing. Education equips investors with the necessary skills and knowledge to navigate the complexities of the manufacturing sector, thereby enhancing their confidence and willingness to invest. Furthermore, access to land plays a critical role in attracting private investment in manufacturing. Investors with larger land holdings are more likely to allocate resources towards establishing or expanding manufacturing facilities, benefiting from economies of scale and operational efficiencies.

Conclusions

In conclusion, this study has provided valuable insights into the determinants of private investment in the manufacturing sector of Ethiopia, with a specific focus on evidence from Ambo Town. By examining the significance of education level and land size as key explanatory variables, the research has shed light on the factors shaping investment decisions among local entrepreneurs and investors.

The findings of this study indicate that both education level and land size significantly influence private investment in the manufacturing sector. Higher levels of education among investors are associated with increased investment in manufacturing, highlighting the importance of human capital in driving investment decisions. Furthermore, access to land emerges as a critical determinant, with investors possessing larger land holdings being more likely to allocate resources towards manufacturing activities.

These findings have important implications for policymakers, investors, and development practitioners seeking to promote private investment and industrialization in Ethiopia. By recognizing the significance of education and land availability, policymakers can design targeted interventions and policy reforms aimed at creating a conducive environment for investment in the manufacturing sector. Investments in education and skills development can enhance the capacity of local entrepreneurs and attract more investment to the manufacturing sector. Additionally, measures to improve land access and streamline land administration processes can unlock the investment potential and facilitate the expansion of manufacturing activities in Ethiopia.

Policy Recommendations

Based on the findings of this study, the following policy recommendations are proposed to promote private investment in the manufacturing sector of Ethiopia:

 Investment in Education and Skills Development: Policymakers should prioritize investments in education and skills development programs aimed at equipping local entrepreneurs with the necessary knowledge and capabilities to engage in manufacturing activities. This could include expanding access to vocational training programs and technical education, as well as promoting entrepreneurship education initiatives.

 Land Reform and Access: Efforts should be made to streamline land administration processes and improve land access for potential investors in the manufacturing sector. This may involve implementing land reform policies to address issues related to land ownership, registration, and transfer, as well as facilitating the provision of land for industrial purposes through targeted land allocation schemes.

 Infrastructure Development: Infrastructure development plays a crucial role in supporting manufacturing activities and attracting private investment. Therefore, policymakers should prioritize investments in infrastructure, including transportation networks, energy supply, and industrial parks, to enhance the competitiveness of the manufacturing sector and create an enabling environment for investment.

 Promotion of Public-Private Partnerships: Encouraging collaboration between the public and private sectors can help leverage resources and expertise to support investment in the manufacturing sector. Policymakers should explore opportunities for public-private partnerships (PPPs) in infrastructure development, technology transfer, and skills training initiatives to foster a conducive environment for private investment.

 Policy Stability and Institutional Support: Finally, ensuring policy stability and providing institutional support are essential for promoting private investment in the manufacturing sector. Policymakers should prioritize regulatory reforms aimed at improving the business environment, reducing bureaucratic hurdles, and enhancing investor confidence. Additionally, strengthening institutional capacity and providing targeted support services to potential investors can help facilitate investment decision-making and implementation.

 By implementing these policy recommendations, Ethiopia can create an enabling environment for private investment in the manufacturing sector, driving sustainable economic growth, job creation, and industrial development in the country.

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Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and formal analysis were performed by all. The original draft of the manuscript was written by all authors and commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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RESEARCH PAPER

Key Factors Affecting Beef Cattle Marketing and Its Profitability: The case of Ethiopia's Oromia Regional State's West Showa Zone

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Abstract

This research was carried out in the West Showa administrative zone in Oromia regional states, Ethiopia. Analysis of beef cattle marketing profitability and its important determinants among smallholder farmers who raise and market beef cattle was one of the main goals of the research. By adopting the scheduled interview data collection approach, 12 well-trained data collectors who were pooled from Development Agents collected socioeconomic data from 400 beef cattle producers and performers who were selected at random. The collected data was analyzed using a multiple regression econometric model and descriptive statistics techniques. The results of the multiple linear regression showed that family size, the frequency of extension visits annually, the distance from and to the nearest market, the experience of the smallholder farmers in the production, raising, and keeping of beef cattle, and the ownership of beef cattle all had a significant impact on their participation in the market and their profitability. Evidence from a marketing gross margin analysis indicated that beef cattle producers earn the largest profit gross margin (49.63%), followed in their earnings by butcheries (40.35%) and hotels (36%). Compared to beef cattle actors, beef cattle merchants have the lowest gross profit margins (27%). The data analysis result suggested that the concerned body should provide adequate and continuous extension services for the beef cattle producers, the policymakers have to construct sufficient infrastructures such as roads and others in the study area and increase the number of beef cattle owned by the smallholder farmers, provision of adequate veterinary service and provision of improve beef cattle breeds are highly recommended in the future interventions.

Keywords: Key factors, beef cattle, gross margin, profitability, value chain

Introduction

Agriculture is the mainstay of the African and Ethiopian economies. About 70% of Ethiopia's workforce is employed in agriculture, which also accounts for about 35% of the country's GDP and 12% to 15% of foreign exchange revenues (World Bank, 2020). However, the agricultural sector is dominated by smallholder subsistence farming.

Ethiopia ranks first in Africa in terms of beef cattle population, but the capability of this subsector to improve the farmers' economic viability is not clearly shown in livestock farmers in general and beef cattle smallholder farmers in particular (Mekuriaw and Harris, 2021).

Despite the enormous number of beef cattle in Ethiopia generally and in the west Showa Zone specifically, there are few animals supplied to the market. Farmers who raise beef cattle are reluctant to sell their animals to marketplaces. Various issues, including a lack of market intelligence, poor transportation, and inadequate infrastructure development, contribute to the smaller quantities of beef cattle that are supplied to the market (Deng, 2020).

Concepts of markets and marketing

The word "market" has several meanings. It may refer to a real place where people meet to exchange products and services (Meshack, 2015). On the other hand, Kotler (2007) defined a market as a system where buyers and sellers regularly engage, enabling the transfer of ownership of goods and services. The system is driven by supply and demand dynamics. A market is made up of people who can afford certain products or services and have the necessary needs to buy those (Mdoe *et al*., 2019). This allows for interactions that benefit both parties.

Smallholder farmers in many Sub-Saharan African nations have little negotiating leverage, especially when it comes to local producers of beef cattle. Farmers frequently turn on unofficial networks (tradespeople, friends, and family) for market information as a result of insufficient public information channels (FAO, 2015). Agricultural product marketing requires effective marketing management techniques that prioritize the marketing mix, which consists of price, place, promotion, and product. "Market potential, production, and financial elements of selling and distributing beef cattle and their products are all included in the term "beef cattle marketing" (Puarada and Gurning, 2022).

Market Involvement

Agribusiness market involvement is essential and has been characterized in a number of ways. It entails taking part in market activities that support the sale of crops and improve farm households' financial situation through exchanges of cash, goods, or services (Paul *et al*., 2021). In order to boost revenue and lessen poverty, market participation can also refer to the integration of subsistence producers into input and product markets (Jagwe *et al*., 2010). Access to markets, which enables smallholder farmers to sell directly to customers or transport their goods to markets, is a crucial component of market engagement (Osmani and Hossain, 2015).

Numerous variables impacting market involvement are highlighted by studies on smallholder farmers' market participation in Sub-Saharan Africa. For example, a study conducted in Ethiopia found that important factors impacting market participation were family size, distance to the closest market, number of hens maintained, breed of poultry, and education level of the household head (Tarekegn and Yosefe, 2017). High transportation costs, inadequate infrastructure, high dependence ratios, market distance, cooperative membership, and output size were found to be obstacles to effective market participation in research conducted in Northern Taraba State, Nigeria (Tang et al., 2022). According to research conducted in South Africa and Nigeria, obstacles that impede market access include inadequate market infrastructure, inadequate usage of grades and standards, inadequate market knowledge, inadequate market transportation, and bad organizational maintenance (Schalkwyk *et al*., 2021).

Transaction Costs

Transaction costs, sometimes referred to as "hidden costs," in the marketing of beef cattle include both visible and invisible expenses related to the exchange of products and services (Jagwe *et al*., 2021). Friction in the transaction process, which includes the transfer and enforcement of ownership rights, is the cause of these expenses. The reason behind some farmers' participation in markets and others' independence might be attributed to transaction expenses. Smallholders' involvement in the market is probably influenced by variations in transaction costs as well as their access to resources and services that help to offset these costs.

Fixed transaction costs (FTCs) and variable or proportional transaction costs (PTCs) are the two types of transaction costs. Regardless of the volume sold, locating trade partners, negotiating, and contract enforcement expenses are all included in FTCs, particularly in credit sales where managing the default risk is necessary (Fafchamps, 2008). Transportation charges and other moving-related expenditures

are included in PTCs, which change depending on the amount transacted. Ineffective market usage is caused by high infrastructure expenses, insufficient market transportation, a lack of market expertise, and inadequate organizational support (Makhura *et al*., 2021).

Gross Marketing Margin and Profitability

In marketing, "price spread" and "gross margin" is not the same thing. The difference between what a market participant pays and receives is known as the gross margin. For instance, in meat markets, the value of the carcass and by-products less the value of the animal is used to determine the packer's gross margin per head of cattle. Smallholder beef cattle farmers find it challenging to obtain financial services in rural Africa due to the frequent absence of financial markets. As a result, cattle, particularly beef cattle, are employed as substitute financial instruments for risk management and wealth accumulation (Islam and Maitra, 2018).

Small-scale producers of beef cattle in developing nations encounter difficulties in reaching markets because they lack the requisite knowledge and abilities. Inadequate dissemination of information and additional obstacles impede market access or restrict the advantages of involvement. Farmers have few choices for diversifying their income outside of growing cattle due to the unsatisfactory pay and disorderly sales that arise from the poor link between output and the market (Mussema *et al*., 2013).

Many beef cattle development initiatives have little effect on output and productivity in terms of reducing poverty and ensuring food security for rural communities in sub-Saharan African countries (Hatab *et al*., 2019). Animals in traditional livestock systems in Sub-Saharan Africa frequently forage for food, water, and shelter without access to veterinary care (Covarruvias *et al*., 2012).

Nevertheless, raising livestock serves a variety of reasons for subsistence farmers, including socioeconomic advantages including savings, manure, skins, insurance against crop failure, and investment diversification (Weyori *et al*., 2018).

Development plans sometimes fail to acknowledge the complexity of livestock production systems in rural households, which results in poor productivity and inefficient livestock policies in SSA nations like Ghana (Salmon *et al*., 2018). Cattle development initiatives should be strengthened by taking into account the economic and cultural responsibilities that livestock play, which are typical in other countries (Traore *et al*., 2017; Ejlertsen *et al*., 2013).

Value-related considerations plays a major role in the reason non-market advantages in beef cattle programs are frequently disregarded. For evaluating subsistence beef cattle systems, policy analysts and technical staff must employ more sophisticated techniques than the conventional cost and benefit analysis approaches (Al-Khalidi *et al*., 2013; Zezza *et al*., 2016). Due to a lack of information flow, a variety of entrance hurdles, and insufficient market knowledge and skills, small-scale manufacturers in developing nations have difficulty accessing markets. This limits farmers' possibilities for income diversification by causing disorderly sales and poor pay (Mussema *et al*., 2018).

Diverse agricultural commodities exhibit differing levels of market efficiency and profitability, according to research on profit analysis and market margin. According to research conducted in Addis Ababa, smallholders' portion of the selling price decreased with time, and butchers had a substantial profit margin of 31.7% (Yacob, 2020). According to Solomon's (2004) study, farmers earned a lesser fraction of the overall gross marketing margin, but meat dealers in Addis Ababa obtained a bigger proportion in the southern area of Ethiopia.

Numerous livestock development strategies in SSA nations have minimal impact on productivity and production of beef cattle in terms of reducing poverty and ensuring food security for rural communities (Hatab *et al*.,

2019). Cattle in traditional livestock systems often forage for food, water, and shelter without access to veterinary care (Covarrubias *et al*., 2012).

Livestock is raised by subsistence farmers for a variety of reasons, including socioeconomic advantages such manure, hides, savings, crop failure insurance, and investment diversification (Weyori *et al*., 2018). Because animals serve so many purposes in rural farm homes, the systems for producing livestock are complicated. But these complexities are frequently overlooked by development attempts, which results in ineffective regulations and low livestock output (Salmon et al., 2018). The efficiency of initiatives to promote cattle might be increased by including the socioeconomic and cultural aspects of livestock in development plans (Traore *et al*., 2017; Ejlertsen *et al*., 2013).

In conclusion, Sub-Saharan Africa's marketplaces and marketing provide a number of difficulties, especially for smallholder farmers. In order to address these problems, comprehensive approaches that take into account the socioeconomic and cultural functions of cattle as well as increase market access, lower transaction costs, and improve market knowledge are needed. Smallholder farmers may boost their revenue, engage more effectively in markets, and advance the growth of the agricultural industry as a whole by doing this.

Materials and methods

The research study was undertaken in West Showa Zone, (Toke Kutaye, Bako Tibe and Ejere districts) Oromia region, Ethiopia.

To choose sample farm household head, a three-stage sampling method was used. In the 1st and 2nd stage, Oromia Regional State, West Showa Zone and the three districts were purposively selected because of their easy accessibility and their potential in beef cattle production and marketing. Finally, in the 3rd stage sample residences were chosen at random from families that raise beef cattle in each peasant association (PA).

Table 1. Sample farm families' distribution within the Districts and PAs

Selected District	Total no of cattle producers in the district	Sample size per District	Selected PAs	Sample size per PA
Ejere	112,000	189		
			Kimoye	54
			Dhamottu	70
			Gaba Jimata	65
Bako Tibbe	110,000	187		
			Dambi Dima	62
			Dambi Gobbu	66
			Shoboka	59
Tokke Kuttaye	13, 516	24		
			Malka Dhaga	6
			Dhaga File	10
			Birbirssa	8
Total	235,516	400	9	400

Source: own survey data computation, 2023

Based on the size of the beef cattle herd and market accessibility, basic random sampling was utilized to choose PAs and marketplaces. Three PAs from each district were chosen using the basic random sampling approach, for a total of nine PAs throughout the three districts. The zone was grouped into three homogenous clusters namely the highland, the midland, and the lowland. One district from each homogeneous cluster districts was randomly selected by lottery method. That is one district from high land, one district from midland, and one district from low land.

Based on Taro Yemane's (1967) technique for calculating sample size, 400 respondents who are beef cattle farmers in total were selected for the study. As given:

$$n = N/[1+N(e)2] \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, n=sample size,
N= Population size,
e= the degree of precision, articulated as a proportion = 0.05
Accordingly;

$$n \equiv \frac{235{,}516}{[1+235{,}516(0.05)2]} \approx 400 \quad \ldots\ldots\ldots (2)$$

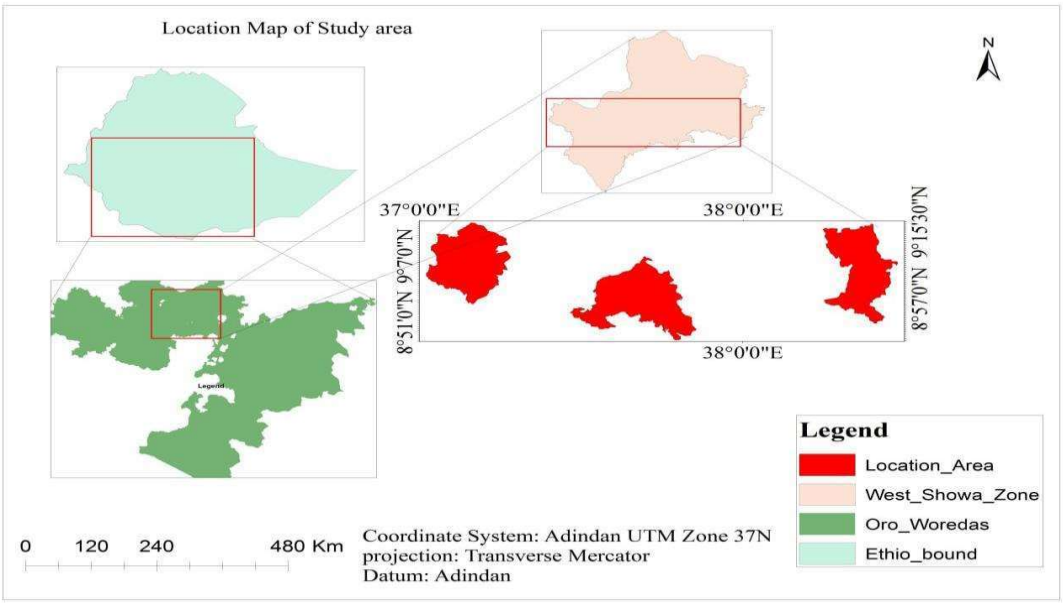

Figure 1. Map of the study area
Source: Zone Agricultural Development Office and Own Computation (2023)

Methods of Data Analysis

Data analysis was undertaken by the use of descriptive statistics /Gross Margin/ and inferential statistics /multiple regression analysis/. An aspect study of the accounts of the firms is necessary to determine the Gross Margin of various enterprises in varying levels along actors in the beef cattle value chain, noting exactly the costs incurred and the value generated at each stage with the value-added nods (Kadigi *et al., 2013*; Debertin, 1993). Gross Margin in order to analyze the profit for local beef cattle and beef cattle products were used. The gross margin association is given as:

$$GrossM\arg in = TR - TVC \quad \ldots\ldots\ldots\ldots (3)$$

TR stands for Total Revenue (sales of beef cattle) and TVC for Total Variable Costs (i.e. feeds, labor cost, fuel cost, transport cost, electricity, maintenance, animal health costs, etc.).

Determinants of Beef Cattle Marketing Profitability In determining the determinants of live cattle marketing profitability multiple regression analysis was used. Utilizing a profit function, regression analysis was generated to the association between these factors and profit as;

$$\prod i_j = f(x_{ij}) \quad \text{……...….. (4)}$$

The profit function was calculated using the Multiple Linear Regression Model, as illustrated in Equation 4. That is as a proxy for Marketing Gross Margin.

$$\prod_{ij} = \alpha + \beta_i x_{ij} + u_j \quad \text{…….. (5)}$$

Where,

$\prod_{ij}$= Profit for i^{th} respondent in j^{th} District.

u = The Y-intercept or a constant term.

$\beta_{ij=}$ independent variable coefficients.

μ_{ij} = The Error term or the disturbance term, referring to whole variables which impact the variation of the independent variables

The gross margin is the output value (gross value of production) of a single firm less the variable expenses directly associated with producing the value. For the investigation of beef cattle farmers' profitability, gross margin was employed as a stand-in.

The profitability of the beef cattle marketing was calculated by using the Gross Marketing Margin formula. Which is given as,

Gross Marketing Margin /GM/ =TR - TVC

Where,

GM = Gross Margin

TR =Total Revenue

TVC = Total Variable Cost

The factors that affect a farmer's profitability were examined using multiple regression analysis. The following are the model's specifications:

The factors that affect a farmer's profitability were examined using multiple regression analysis. The following are the model's specifications:

$$Yi = \beta_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + B_8X_8 + U_i \quad \text{... (6)}$$

Where,

Yi is the GM, B_0 is constant of the equation, *and Bi* is coefficient of the explanatory variables.

Xi = Independent variables. U_t is the error term or unexplained variation.

Results and discussions

The research survey data analised output indicated that beef cattle farmers get the highest profit gross margin (49.63%), this is mainly because of cost minimization. For instance,, most farmers do not purchase animal feeds, they use from their lands and crop leftovers, except for some minerals such as salt and the like. Butcheries got the second highest profit gross margin (40.35%). This is mainly because of profit maximization. They increase the price of a kilo of meat to get higher profits. Hotels got the third profit gross margin (36%), and beef cattle traders got the fourth profit gross margins (27%) along the beef cattle marketing value chain actors, (Table, 2,3,4.5) respectively. Results similar to those found by (Nkadimeng *et al*., 2021) and (Camilla *et al*., 2022) dealing with goat marketing in South Africa.

Table 2: Gross margin analysis for beef cattle Farmers taking average costs

No.	Description	Cost in Birr/year	Proportion of TVC (%)
	Cost /Birr		
1	Labour for herding	4081.30	24.69
2	Dipping/Spraying	134.13	0.81
3	Drugs/Medications	2,392.80	14.47
4	Deworming	1,140.40	6.90
5	Feed	9,415	56.95
6	Other Variable Costs	3,450	20.87
	Total Variable Costs	16,532.33	100
	Revenue		
1	Selling Price /average/ /Birr	32,820	
2	Gross Margins(GM) /Birr	16,287.67	
3	GM as a % of sales	49.63	

Source, Survey data output, 2023

Table 3. Gross margins for beef cattle traders

Cost Description	Unit Cost/Head /Birr/	%age of TVC
Average Cost of One Cattle		
Purchasing Price	29,788.13	71.26
Movement permit	131.05	0.31
Market fees	54	0.13
Transportation (Buying)	7,000	16.75
Transportation (Selling)	3500	8.37
Communication	9.65	0.02
feed	310	0.74
Labour (header wages)	145.66	0.35
trekking	863.33	2.07
Total costs	41,801.82	100
Income from the sale of a single beef cattle		
Average retailing value/Price/ of cattle	57,957.08	
Gross Margin	16,155.26	
Gross margin as a % of sales	27.87	

Source, Survey data output, 2023

Table 4. Gross Margin Analysis for Butchery

No	Description	Cost in Birr	% of TVC
1	Purchasing Price (Average live cattle)	40,754.64	95.48
2	Buying /movement permit	80	0.19
3	Market (charges) fees	40	0.09
4	Transportation (to slaughtering and shop)	360	0.84
5	Holding pen fee	200	0.47
6	Slaughtering fee	400	0.94
7	Labour (meat seller)	200	0.47
8	Others	650	1.52
	Total Costs	**42,684.64**	**100**
	Income from the sale of a single beef cattle		
	Carcass 1kg @600 Birr	66,000	
	Head	300	
	Hide	30	
	Offal and legs	1,200	
	Others	4,000	
	Total Revenue	71,530	
	Gross margin	28,865.36	
	Gross margin as a % of sales	40.35	

Source, Survey data output, 2023

Table 5. Gross Margin Analysis for Hotels

No	Description/week	Cost in Birr	% of TVC
1	Purchasing Price (Average) Meat	2,400	73.17
2	Labour (seller and service giver)	300	9.15
3	Transportation	80	2.44
4	Others	500	15.24
	Total Cost	3,280	100
	Revenue from the sale of one beef cattle		
1	Meat (Birr)	3,600	
2	Meat plus other foods	1,022.86	
3	Others	502.56	
	Total Revenue	5,125.42	
1	Gross margin	1,845.42	
2	Gross margin as a % of sales	36	

Source, Survey data output, 2023

Gross margin was utilized as a stand-in for assessing the drivers of beef cattle marketing profitability in the analysis of those factors. Five of the eight variables that were introduced into the multiple regressions model, the number of household members had a positive impact on the profitability of beef cattle marketing at a level of significance below 5%, according to the model's output data. A similar finding was made using another method by Jobirov *et al*., (2022). They found that a number of household members considerably and favourably influenced profitability with beef cattle farmers marketing with 5% or less significant level in the Baljovan District of Khatlon region, Tajikistan. The tumber of extension visits per year affected beef cattle marketing profitability positively at less than 1% significant level, same finding was obtained by (Ehinmowo *et al.*, 2015), and they found that number of extension visits significantly affected beef cattle marketing profitability in Nigeria by less than 5% significant level.

Distance from and to the nearest market affected beef cattle marketing profitability negatively, at less than 1% significant level; a similar result was obtained by K Natukunda *et al*., (2011).

Experience of the farmer in beef cattle keeping affected profitability of beef cattle marketing negatively at less than 5% significant level. A similar result was obtained by (Nkadimen *et al.*, 2021), and the number of beef cattle owned significantly affected the profitability of beef cattle marketing positively at less than 1% significant level. A negative outcome was obtained by (Jobirov *et al*., (2022). They found that number of beef cattle owned significantly affected the profitability of beef cattle marketing negatively at less than 1% significant level.

Moreover, the experience of the farmer was statistically significant at probability less than 0.05 and negatively to Gross Margin. According to this result, farmers with many years of experience compared to farmers with less years of expertise, have a better likelihood of earning a higher gross margin. However, after some years of experience, farmers become laggards/resistant to changes/ and can't increase their Gross Margin or profit. If the experience in raising beef cattle rises by a year for the farmer, Gross margin or profit decreases by 528.71 Birr/cattle keeping all other variables kept constant. On the contrary Nganga *et al*., (2010) indicated that, due to their technical expertise, which is affected by having worked in the field for a considerable amount of time, farmers with greater experience typically display better levels of profit margins. Further research is required in this regard.

In contrast, education level, access to information and land size owned were found to be non-significant variables, (Table 6).

Table 6. Regression output on determinants of Beef Cattle Profitably

Variables	B	Std. Error	P-value	VIF
(Constant)	-4182.174	6339.028	.510	
Number of house hold members	1460.106	618.519	.019**	1.242
Education Level	-883.978	1373.070	.520	1.359
Access to information	1480.448	4487.237	.742	1.292
No of Extension visit/year	792.543	173.971	.000***	1.438
Distance to the nearest market	-1321.033	658.365	.045**	1.162
Land size owned (Heck)	1212.253	1263.811	.338	1.308
Experience in Cattle farming	-528.708	236.438	.026**	1.814
Number of Cattle owned	1258.124	457.174	.006***	1.432
Observation	400			
R	0.862			
R^2	0.790			
Adjustment R^2	0.766			

At a 1% and 5% significant level, respectively, *** and **.

Source, Survey data output, 2023

As can be seen from Table 5 above, the number of household members, number of extension visits/year, distance to the nearest market, experience in cattle farming and number of beef Cattle owned significantly affected beef cattle marketing profitability at different significant level. These findings are in line with Jabrov *et al.*(2022), Deogratius *et al.* (2023), Kassa *et al*.(2022) and Jimoh *et al* . (2023).

Conclusions

To calculate the /Gross Margin/ profit earned by various players at the various value-chain nodes were used. According to the results, farmers received the greatest Gross Margin (49.63%), butcheries the second-largest Gross Margin (44.35%), hotels the third-largest Gross Margin (36%) and traders the fourth-largest Gross Margin (27.87%) in the beef cattle value chain of operations.

The other objective involved was researching the key factors that affect beef cattle farmers' profitability in the districts of Bako Tibe, Toke Kutaye, and Ejere. The results revealed that the number of household members, the number of Extension visits each year, the distance from and to the nearest market, the amount of years' experience in beef cattle farming, and the number of cattle owned all had a beneficial impact on profitability at different significant levels. As opposed to that, components such as education standards, information availability, and size of the land owned were determined to be non-significant factors in the beef cattle marketing value chain actors profitability.

Policy Implications and Recommendations

1. It was shown that number of extension visit affected the beef cattle marketing profitability positively, the concerned body should provide adequate and continuous extension services for the beef cattle producers,

2. The distance from and to the nearest market affected the beef cattle marketing profitability negatively. In here we recommend the policy makers to construct sufficient infrastractures such as roads and others in the study area and

3. The number of beef cattle owned affected the beef cattle marketing profitability positively. To increase the number of beef cattle of the small holder farmers, provision of adequate veterinary service and provision of improve beef cattle are highly recommended.

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Declaration of Conflict of Interest

We all authors have no conflict of interest either in financial situations or in any other interests.

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RESEARCH PAPER

Job Market for Data Science and Big Data in East Africa

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Abstract

Nowadays big data have been impacting the working culture and working environment of business organizations worldwide. Big data has become an important asset of the business. The main reason is that the insights have been obtained from these data to enable organizations to be better competent in the market. Thus, those organizations using big data for informed decision-making are better benefited than the organizations that are not using it. However, the job role of data science and big data as well as the skills required for the position is not well-identified and distinguished. These issues are the main current challenges in the job market for big data and data science to get the right skilled manpower for the required position. This raises the need for appropriate categories of job positions and skills required to use the data effectively and efficiently for smart decisions and strategic planning in business organizations. The purpose of this study is two-fold. The first is to identify the job market/job position for data science and big data professions. The second is to list out skills required for these job positions in the job market. Data that relate to big data and data science from job advertising posts are collected from online job-related websites and categorized into clusters of job positions. The clustering task is based on the analysis of some commonalities as well as differences observed in the professions. Besides skills required have been identified and listed. The findings show that data scientists, data analysts, and data engineers are identified as popular career paths for the required job market with the required skills in East Africa. As a concluding remark, this research underscores the importance of establishing appropriate job categories and skill sets to effectively leverage big data for informed decision-making and strategic planning within business organizations.

Keywords: Big data, data science, skills required, job positions, job market, job advertisements

Introduction

The advent of big data technology and the data science knowledge domain increased career opportunities to grow exponentially. To fill these needs, Universities and training centers should deliver relevant knowledge and should enable the trainee to possess the required skills (IE-School of Human Science and Technology, 2020). However, there are no clear distinctions between the knowledge domain and skills required for those career opportunities in the job market so hiring companies cannot get the right human resources who possess the right skills that can fit the right position. Davenport and Patil (2012) in Harvard Business Review reported that “if capitalizing on big data depends on hiring scarce data scientists, then the challenge for managers is to learn how to identify that talent, attract it to an enterprise, and make it productive” (Akter *et al*., 2019; Khanra *et al*., 2020).

To identify the knowledge domain and skills required in the field, it is better to understand the relationship between big data, data science, and machine learning. NIST (2019) defines big data as " consists of extensive datasets - primarily in the characteristics of volume, velocity, variety, and/or variability - that require a scalable architecture for efficient storage, manipulation, and analysis."

Most experts and scientists in the discipline of data science define big data by its characteristics. The main characteristics are volume, velocity, and variety. They call it 3V's. However, to define big data in a better way, others include additional characteristics such as veracity, value, vision, verification, validation, complexity, and immutability. Measurement of data in terms of gigabyte, terabyte, or petabyte refers to volume; whereas the speed in which data is generated in terms of time refers to velocity and heterogeneous types of data refer to variety. Besides these main characteristics of Big Data, the added ones have been seen as follows. Vision is used to express the purpose, while verification is used to express confirmation of processed data to some defined specifications. Validation is also used to express the purpose of predefined fulfillment, while the value is used to express that extracted relevant and significant information can be used for a different purpose. Complexity is also another characteristic used to express the difficulty of big data to organize and analyze. Finally, immutability is used to express well-managed big data as it can stay permanent (Oussous *et al*., 2018; Beręsewicz *et al*., 2018).

According to NIST (2019), "Data science is the methodology for the synthesis of useful knowledge directly from data through a process of discovery or hypothesis formulation and hypothesis testing." Since data science includes analytics steps in its process, it is highly linked and used in the analysis of big data. Data science is an interdisciplinary field (as it has been seen in figure 1) so it correlates with statistics, mathematics, data mining, software, and system engineering, algorithms, analytic systems, machine learning, and so on.

Figure 1: Data Science Sub-disciplines (source: NIST (2019))

From these sub-disciplines knowledge domain, machine learning has the lion's share in data analytics to get insight from data of business organizations. Machine learning is one of the areas of computer science. It has been there for decades solving problems in the domain. Arthur Lee Samuel was the first man who defined machine learning as one of the disciplines that were able to learn programs around 60 years ago. The first machine learning algorithms were written by SAS in 1979. Advancements in the area came in the 1990s with approaches including neural networks, decision trees, and ensemble models that integrate multiple machine learning algorithms to enhance the accuracy of predictions. Today,

the most popular online service provider like Google, Amazon, and Netflix are using machine learning in their work. There are two types of machine learning (Muezzinoglu *et al*., 2018).

Currently, data scientists are commonly using machine learning in big data analytics. It is used in the application areas such as the financial industry, aviation industry, crime protection, and identifications, robotics industry, telecommunication industry, autonomous cars industry, and others to analyze data, predict, and make intelligent decisions (Muezzinoglu *et al*., 2018; Strau, 2018).

In machine learning, the model-based approach discussed by Breuker (2014) and Muezzinoglu et al., (2018), is one of the techniques implemented in data analytics. By choosing one of the available algorithms in the library, tasks will overtake and be executed on the model. This enables us to have algorithms for the specific implementation.

In East Africa, countries like Kenya, Tanzania, Uganda, Rwanda, and Ethiopia were witnessing a rise in opportunities for data professionals. Industries such as finance, telecommunications, healthcare, agriculture, and e-commerce were actively seeking skilled individuals to help them make sense of their data and gain a competitive edge (KICTANet, 2023).

Here, the question is why a need to know the role and skills required in data science and big data. The basic reason is to achieve the objective of the study. That is to identify the job categories and skills required in the area so that business companies hire the right human resources they need. Besides, University and educational training centers deliver relevant knowledge and skills to fill the needs of the industries. Therefore, to achieve the objective of the study, the following research questions have been developed.

1. What are the job market/job positions for data science and big data professionals in East Africa so that hiring companies get the right human resources that can fit the right position?

2. What are the skills required in the job market/job positions of data science and big data professionals in East Africa so that hiring companies get the right human resource that possesses the right skills?

Methods

The approach used for this study is a systematic review and cluster analysis method is used to analyze the collected data. The following search keys were developed to collect relevant primary data based on the research questions.

((Careers in Data Science OR Job Roles in Data Science) AND (Data Analyst OR Data Engineer OR Data Scientist OR Database Administrator OR Machine Learning Engineer OR Data Architect OR Business Analyst OR Data and Analytics Manager OR Data Visualization Specialist OR Consultant Data Management OR Big Data Engineer OR Data Science Specialist OR Research Data Manager OR Data Lifecycle Expert OR Analytics Lead OR Data Science and Big Data Consultant OR Big Data Specialist OR Dig data software engineer OR Lead Data Engineer OR Data Ops Engineer OR Data Management Specialist OR Lead Data Solutions Architect OR Data Protection and Storage Engineer OR Systems Data Protection and Storage Engineer OR Machine Learning Software Engineer)).

To search and collect relevant data, the following Websites and search engines are used as sources of data. These websites are selected based on their relevance and popularity in posting job vacancies in East Africa.

1. https://www.EthioJobs.net
2. https://www.LinkedIn.com
3. https://www.tapwage.com
4. https://www.unjobnet.org
5. ttps://www.ethiopiawork.com/africawork.com
6. https://www.Google.com/Jobs vacancy

The following Inclusion and Exclusion criteria are used to filter collected data for relevance. As inclusion criteria, any industry with relevant data concerning data science, and big data is

included. The data should be only from East African countries such as Djibouti, Eritrea, Ethiopia, the Democratic Republic of the Congo, Somalia, Burundi, Kenya, Rwanda, South Sudan, Uganda, and Tanzania. The years of vacancy posted should be between 2012 and 2023. Whereas job position with the same name but which has no link with data science and big data are excluded from collected data. Also, skills posted by job vacancy advertising but not related to data are excluded from skills required for job position categories.

Results and discussions

From many posted job advertising vacancies, 22 job vacancies that relate to big data and data science are collected. According to IE-School of Human Science and Technology (2020) nowadays, a few career paths in big data and data science in a worldwide context are Machine learning engineer, Data architect, Statistician, Data analyst, Chief technology officer, chief data officer (CDO), Application Architect, Project manager, Market research analyst, Business/analytics translator, Data scientist, and so on. Based on this fact, the collected data was analyzed and categorized into different groups on their similarities and differences using the cluster analysis method. Furthermore, based on the inclusion and exclusion criteria two vacancies are excluded so that the numbers are reduced to 20. Finally, from 20 vacancies available for grouping into their similarities, 5 clusters have been formed. 8 vacancies are categorized to data scientist, 8 vacancies are categorized to data analyst, 2 vacancies are categorized to data engineer, 1 vacancy is categorized to data management, and 1 vacancy is categorized to big data program officer.

Intern and advisory/consultancy are categorized under relevant job vacancies, not separately. The result revealed that data scientists and data analysts are job positions in data science and big data professions that most companies in East Africa need to hire. The related skills required for these job positions are shown in the tables below (see Tables 2, 3, and 4 for details).

Table 1. Clusters of job vacancy

SN	Job vacancy	Frequency	%
1	Data Scientist	8	40
2	Data Analyst	8	40
3	Data Engineer	2	10
4	Data Management	1	5
5	Big data program officer	1	5

The findings show that data scientist and data analyst are the two job positions in data science and big data profession that most companies in East Africa need to hire for their data-related tasks. On the other hand, the educational qualification for big data and data science job market has seen almost the same in all job role categories. The skills required are also overlapping to some extent but have important differences. This implies that the skills difference may arise from exposure to the industries or skills acquired through different skills training centers.

Existing related literature works also highlights the increasing importance of big data in business organizations and the challenges and opportunities in the job market for data science and big data professions. This research emphasizes the need for appropriate job categories and skills for the effective use of big data, particularly in East Africa, while works of literature focuses on the analysis of job advertisements and the multi-faceted nature of big data job skills, including the value placed on soft skills (Gardiner et al., 2018; Regane *et al*., 2024).

Table 2. Skills and educational qualifications required for the role of data scientist

Roles	Skills required	Educational Qualifications
Data scientist	Statistical analysis and computer programming Deep analytical and research skills Personal organization and planning skills Manage and analyze big data Analyze and evaluate the data Create new models of analysis Assist the users Perform the technology watch Quantitative analytics or data modeling Deep understanding of predictive modeling, machine learning, clustering and classification techniques, and algorithms Fluency in a programming language (Python, C, C++, Java, SQL) Familiarity with Big Data frameworks and visualization tools (Cassandra, Hadoop, Spark, Tablea	Data science, Mathematics, Statistics, Computer science, Software engineering, Systems engineering and Information systems

As claimed by NIST (2019) "A data scientist is a practitioner who has sufficient knowledge in the overlapping regimes of business needs, domain knowledge, analytical skills, and software and systems engineering to manage the end-to-end data processes in the analytics life cycle."

Table 3. Skills and educational qualifications required for the role of data analyst

Roles	Skills required	Educational Qualifications
Data analysts	Experience in data models and reporting packages Ability to analyze large data sets An analytical mind and inclination for problem-solving Deep understanding of predictive modeling, machine learning, clustering and classification techniques, and algorithms Knowledge of statistics and experience using statistical packages for analyzing datasets (Excel, SPSS, SAS, etc.) Familiarity with big data frameworks and visualization tools (Cassandra, Hadoop, Spark, Tableau Coding database environments in MySQL, SQL, or other DB languages Fluency in a programming language (Python, C, C++, Java, SQL) Programming experience with frameworks including XML, Javascript, and ETL	Data science, Statistics, Information Technology, Mathematics, Computer Science, Economics, and Information management

Modernanalyst.com (2020) defines a data analyst as "The Data Analyst is the professional whose focus of analysis and problem-solving relates to data, types of data, and relationships among data elements within a business system or IT system." On the other hand, the role of data engineers is defined by Furbush (2018) as "Data engineers are concerned with the production readiness of that data and all that comes with it: formats, scaling, resilience, security, and more".

Table 4: Skills and educational qualifications required for the role of the data engineer

Roles	Skills required	Educational Qualifications
Data Engineer	Experience doing quantitative analysis Fluency in SQL or other programming languages. Basic understanding of statistical analysis Strong coordination and project management skills Excellent analytic skills Expertise in designing and maintaining databases (object, columnar, in-memory, relational) Proven track record of successful communication of data infrastructure, data models, and data engineering Experience with relational data stores as well as one or more NoSQL data stores (e.g. Mongo, Cassandra) Prior experience in data warehouse modernization building complete data warehouse solutions, star/snowflake schema designs, infrastructure components, ETL/ELT pipelines, and reporting/analytic tools Experience building production-grade data backup/restore, and disaster recovery solutions Hands-on experience with batch and streaming data (e.g., Cloud Dataflow, Beam, Spark, Cloud Pub/Sub, Apache Kafka) Advanced SQL skills, and proficiency in one or more programming languages such as Python Familiarity with Python data science tooling (pandas, scipy, sklearn) Demonstrated proficiency with data structures, algorithms, distributed computing, and storage systems	Computer Science, Mathematic, Physics, Engineering, Statistics or other technical fields

Conclusion

To cope with the changing environment in business organizations due to emerging technologies like big data, it is important to understand the knowledge domain and skills required in data science and big data. To identify professions' knowledge domain and skills required in the area, posts on job advertising websites were assessed and analyzed. Finally, data are clustered into different categories based on their similarities. The result of the study shows that data scientists, data analysts, and data engineers are the leading job positions of big data and data science professionals in East Africa. Besides, commonly required skills for these job positions in the professions are listed. Identifying these professional job positions and the skills required helps business organizations

hire the right person for the right position to be competent and profitable.

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RESEARCH PAPER

Literacy Practices within Self-help Groups: A Case Study of Jeldu Functional Adult Literacy (FAL) Groups, Oromia: Ethiopia

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Abstract

The purpose of this study was to assess the effectiveness of literacy practices of self-help groups in Jeldu District. The self-help groups were formed by Meserete Kristos Church Rehabilitation and Development Association in the district. The study employed a mixed research method. Questionnaires, interviews, focus group discussions, and observation were used as instruments of data collection. Questionnaires were used to collect information from ten facilitators, whereas interviews were used to get insider information from the program coordinator, a facilitator. The district ANFE coordinator and five beneficiaries were considered for focus group discussion. The findings revealed that the intervention helped beneficiaries to build high self-esteem and develop an extrovert personality. Acquiring reading, writing, and doing basic arithmetic skills were considered the means to an end. Indeed, the intervention contributed to reducing the withdrawal of adult learners from the literacy program, developing the positive self-concept of beneficiaries, and motivating them to work hard to enhance their livelihood.

Keywords: Literacy, self-help groups, practices, effectiveness

Introduction

Education plays a crucial role in the process of nation-building, for it enhances the physical, mental, and emotional development and productivity of individuals. In Ethiopia, access to basic education has been very limited until recently. To curb the situation and ensure access to basic education, the country has implemented a series of education sector development programs (ESDP) known as ESDP I, II, III, and IV. Because of the relentless efforts made, the enrollment ratio in elementary education has improved significantly. The net enrolment ratio in primary education has increased from 29% to 86% from 1991 to 2014 (WENR, 2018). Although impressive achievement has been registered in primary education, a lot has not been done in the area of adult and non-formal education in ESDP I, II, and III (ESDP VI, 2010).

The country is living with a huge number of illiterate adults whose level of productivity is very low, whose resource management is poor, and whose role differentiation is in line with gender stereotypes. The people observe different days as 'holy' which contributes to weakening their work culture and are deprived of the opportunity to get information (Admasse and Abebaw, 2013). Functional adult literacy has been identified as one of the main agendas in ESDP III and reinforced in ESDP IV (ESDP VI, 2010). The objective of the program was to mitigate the problem of illiteracy, reduce gender stereotyping, and improve the livelihood of adults. A functional adult literacy program aims to empower adult members of society so that they actively participate in national development and play their part in national poverty reduction strategies. The government planned to reach 5.2 million adults in 2008–2009 but has not succeeded, mainly because of a lack of financing, poor coordination, the absence of guidelines and

training, and a shortage of human resources in the area.

A functional adult literacy program is a form of education for young adults whose ages are 15 or older (MoE, 2008). Functional adult literacy deals with the provision of the 3Rs (reading, writing, and numeracy), practical knowledge and skills useful for other aspects of life such as agriculture, health, civic and cultural education, primary health care, prevention of diseases, family planning, environmental protection, marketing, and gender equity (Sonja, 2011). The integrated functional adult literacy program is provided for adult learners so that they make use of their ability to read and write to access information (MoE, 2010). On top of that, the program is intended to improve the living standards of the adult population by providing need-based education and training for adult learners (Tamirat, 2015).

Building the capability of a community cannot be left to the government. NGOs, community-based organizations, private institutes, religious institutes, and individuals would have to play roles. Meserete Kristos Church-Rehabilitation and Development Association (MKC-RDA) has been one of the religious-based non-governmental organizations working to enhance the development of the country at large and the Jeldu District community in particular since 2008. Jeldu is one of the districts in the West Showa Zone of Oromia, located 129 km from the capital city of Addis Ababa to the west and 74 km to the north-east of Ambo. The total population of the district is approximately 282,409 (49% males and 51% females) currently. The altitude ranges from 2900 to 500 meters above sea level. In line with this, the climatic condition of the area ranges from cold to hot. Agriculture is the main source of livelihood for the community (West Shoa Zone Statistical Agency, 2010).

About 93% of the people in Jeldu were from rural communities, whose livelihood by and large depends on subsistence farming. According to the Oromia Education Bureau, more than 77% of the total population in Oroima Regional State was illiterate. The case of Jeldu District was not different, if not worse. MKC-RDA intervened in five Kebeles of the district, which benefited 2,434 adults, of whom 1,497 were male and 937 were female. The beneficiaries of the project were organized into 131 FAL groups, whose name was derived from the functional adult literacy group. The intervention of the project was managed by 11 facilitators. These facilitators were expected to run literacy classes, identify the training needs of FAL groups, and induce and encourage a culture of saving among FAL groups.

Functional adult literacy is an approach used to help adults acquire reading, writing, and basic arithmetic skills and enhance their livelihoods in their locality, which in turn could contribute to the development of the country. A functional adult literacy program is developed through a bottom-up strategy based on the following principles (McCaffery *et al.*, 2007):

- *Local context:* the definition of functionality depends on what kind of reading and writing skills are commonly needed in the learners' community. Therefore, each community needs its own definition of functional literacy.

- *Local design:* the tutors receive training on how to design their learning activities and curriculum, how to make their learning materials, and how to network with local organizations to produce learning materials and resources that meet the needs and interests of target groups.

- *Participatory process:* the learners are involved in all aspects of learning activities. They develop their functional capabilities by making decisions and planning their own learning.

This study was conducted to look at how intervention through MKC-RDA has contributed to improving the quality of life of the target groups and to identify the strategy employed to initiate literacy practices among beneficiaries. It was also meant to examine if

the intervention has positively affected the literacy skills of the beneficiaries.

Research design and methodology

The study employed qualitative and quantitative methods. The sample population consisted of beneficiaries, facilitators, and officials who were in some way involved in adult literacy programs. Instruments of data collection were semi-interviews, focus group discussions, questionnaires, and observation. A questionnaire was used to collect data from 10 facilitators. One facilitator, one education officer, and MKC–RDA program coordinator took part in semi-structured interviews. Five beneficiaries were approached for the success of the intervention. The observation was carried out while the teaching-learning process took place to verify the replies of different stakeholders (Brown, 2006).

Methods of data analysis

The data collected were analyzed qualitatively and quantitatively using percentages to triangulate the findings to reach a valid conclusion..

Results and discussions

Criteria for membership of the FAL groups were one of the issues that needed due consideration. In this regard, facilitators were asked to share their views on issues like being a member of the community, literacy skills, interest, poverty, sex, and sources of livelihood were portrayed in the following table.

Table 1. Criteria to be members of the FAL groups

	Target groups are selected based on	Yes		No	
		No.	%	No.	%
1	Being member of the community	10	100	0	0
2	Literacy skill	4	40	6	60
3	Interest	10	100	0	0
4	Being poor	3	30	7	70
5	Sex	0	0	10	100
6	Sources of livelihood	10	100	0	0

In Table 1, being a member of the community was one of the criteria taken into consideration to be a member of a FAL group, as all facilitators (100%) responded to the question positively (see item 1). Item 2 was meant to find out if literacy was taken as the criterion for the selection of the target group; only four (40%) facilitators said yes, while six (60%) of them replied negatively. Item 3 was forwarded to find out if interest was considered as the criterion for selection. All of them have responded positively, which implies that interest was one of the major criteria for selection. Item 4 was meant to find out if economic status was taken as the criterion. Only 30% of the respondents reported that being poor was one of the requirements, although one of the main purposes of the intervention was to enhance the livelihood of the beneficiaries. Item 5 was asked if sex has been taken as the requirement for selection. All respondents anonymously said that sex was not the criterion. Item 6 was meant to find out if the source of livelihood of the target groups has been viewed as the criterion for selection. All facilitator respondents replied yes to the question. Thus, the data showed that to be a member of the FAL group, being a member of the community, interest, and sources of livelihood were considered outstanding criteria. Being illiterate and poor might encourage a

person to join the group, although it is not mandatory.

Two of the interviewees (the program coordinator and the facilitator) have also agreed with the reply given by the respondents who have taken part in filling out the questionnaire. They said that economic background, age, interest in being a member of the community, and livelihood were the most important factors considered in order for the target groups to be taken as beneficiaries. Literate individuals were also accepted to be members of FAL groups, mainly because the focus of the program was not limited to the provision of literacy skills but also economic empowerment. FGD participants also revealed that the intervention was designed to enhance their livelihood in that some of the beneficiaries of the programs were literate. Thus, members of the community who were members of the FAL groups were empowered because of their participation in the program because the intervention dealt with the holistic development of individuals.

Table 2. Degree of Participation of Learners in Learning Tasks as replied by the facilitators

	Learning tasks	**Participation**			
		Yes		**No**	
		No.	**%**	**No.**	**%**
1.	Participate in need analysis	10	100	0	0
2.	Participate in the formulation of the objectives	7	70	3	30
3.	Participate in the preparation of the contents	7	70	3	30
4.	Participate in the selection of the methods of learning	10	100	0	0

In Table 2, item 1 was meant to find out if FAL groups were allowed to participate in the identification of needs analysis. 10 (100%) facilitator respondents said that FAL groups took part in the identification of needs analysis. Item 2 focused on the formulation of objectives, and it has been revealed that 70% of the facilitators believed learners participated in the preparation of the objectives even though 30% of facilitators replied that learners did not take part in the preparation of the objectives. Item 3 dealt with the preparation of the contents of learning. 7 (70%) facilitator respondents reported that adult learners took part in the preparation of learning contents, while 3 (30%) of them replied negatively. As has been depicted in item 4 of the same table, all facilitator respondents confirmed learners' participation in the selection of methodology. The selection of the method of facilitation was one of the tasks that would hardly be done with the participation of the trainees. This was an indication of the facilitators' limited understanding of methodology. This actually was what the researcher saw during observation in the actual teaching-learning process. The facilitator was trying to talk about poultry. The lesson of the day was about the preparation of places for a day-old chicken at the household level. The method of teaching was totally teacher-centered. He was using words like centimeter and meter that could hardly be understood by the target groups, and he made very little effort to involve FAL groups in the process of learning.

The same questions were raised with the program coordinator and the facilitator. According to them, FAL groups were actively involved in the identification, prioritization, and analysis of needs, which in turn contributed to setting the learning objectives. This was because the organization strongly believed that learning activities would have to be related to

the livelihoods of beneficiaries. Accordingly, objectives were identified and prioritized by the beneficiaries themselves and treated. To meet the desired objectives, the contents of the learning tasks were also identified by facilitators in collaboration with the FAL groups.

Relevance of Learning Tasks

Based on the reactions of the beneficiaries who have taken part in the interview and focus group discussions, beneficiaries were encouraged to reflect on their practices. Participants in the FAL groups were allowed to look at why, when, and how they spent money in kind and cash. According to FGD participants, most of the FAL groups came to understand that they over utilized the meager resources they had whenever holidays were celebrated and in the preparation of marriage feasts. They also over utilized the meager resources they had whenever they hosted parties in recognition of the support a household got from neighbors and friends to plow farmland and harvest crops usually known as 'dabo' (Debo is a communal practice exercised to give a hand to one another whenever needed). In all these and related circumstances, the rural community was required to prepare food and drink. Time concept was another area of debate for the FAL groups. As the coordinator reported, FAL groups reported beneficiaries were highly encouraged to reflect on the utilization of time (being scheduled, and the number of working days within a month). As the participants of the FGD confirmed, "Before the intervention of MKC-RDA, we used to look at different days: days like 'Gebriel', 'Micheal' and so forth." After a series of discussions and reflections were made among FAL groups with the help of facilitators, FAL groups started to ignore the uniqueness of those days and started to engage in their businesses to improve their livelihood. Another important point of discussion was the division of labor. Some of the customs and traditions were in line with gender stereotyping. As FGD participants confirmed, some jobs were reserved for males while others were for females before the intervention. The FAL groups were encouraged to discuss such kinds of issues and began to understand that the stereotyping was only the result of customs and traditions. Having been witnessed by the respondents, one notable example was that the collection of crops from the field during harvest time had been the females' duty. However, after a series of discussions and reflections, both men and women of the FAL groups had begun collecting crops during the harvest season, irrespective of their sex.

Strategies Employed to Ensure Relevance of the Intervention

Membership of the FAL group was purely voluntary and the participants were solely responsible for organizing and grouping themselves according to their interests, aspirations, and capacity. Accordingly, they were required to give themselves a name for their groups. Example: 'Rabbira' which means from God; 'Abdi Guddina' means Hope for Development, and 'Abdi-Waq' means Hope in God. Members of respective groups were encouraged to explicitly state the purpose. Hence, they were allowed to state their objectives and develop strategies to meet the desired results. Such a practice course helped the respective FAL groups to take responsibility for their acts.

Acquisition of reading, writing, and basic arithmetic skills was considered as the means to an end rather than an end in itself. The FAL groups were taught these skills if and only if they were convinced that the ability to read and write were important and helpful in improving their livelihood. As the coordinator of the program reported, "The organization helped the participants to realize the importance of the three skills in building their capability." The intervention initiated by MKC-RDA did not perceive beneficiaries as subordinates, dependents, poor, helpless, and needy. Rather, as capable and resourceful, whose knowledge and experience counted most. That helped the beneficiaries to build high self-esteem and develop extroverted personalities who continued to contribute to the betterment of the community by sharing the knowledge and

experience they gained because of the intervention.

Major Changes Observed Because of the Intervention

Literacy activity in West Showa is characterized by learners' withdrawal, a lack of commitment from facilitators, problems related to the motivation of learners, a lack of cooperation among stakeholders, and problems with the relevance of the curriculum (Kebede and Solomon, 2010). The researcher tried to find out the literacy activity observed in the MKC-RDA intervention, taking into consideration the issues of adult learners' withdrawal, relevance of curriculum, cooperation of stakeholders, and facilitators' commitment. Based on the attendance sheet and other supporting documents, it has been learned that withdrawal was not the problem, and the FAL groups attended their literacy class as per the schedule consistently. As the coordinator of MKC-RDA said, FAL groups were highly motivated, mainly because participation in the program was purely voluntary and the learning experiences were need-based. Participants in the focus group discussion (FDG) also asserted that membership of the FAL group was purely voluntary and that it was the participants who decided almost everything as a team. Concerning the curriculum, as the coordinator reported, FAL groups are actively involved in the process of design, implementation, and evaluation of the curriculum.

Another notable change observed in the beneficiaries was their attitude towards their future. They started to realize the possibility of making a difference in their livelihood and began to aspire for improvement. As participants in the FDG have confirmed, "We started to work hard, and our productivity has increased significantly." The FAL groups also cleared up bushes and leveled about six kilometers to make a road. The road, as the researcher observed, could be used by small vehicles with some difficulty during the dry season.

Beneficiaries got acceptance, and they were contributing to raise awareness of the community as a result of being part of the groups and building a strong household. According to the focus group participants, friends and colleagues who were not accommodated in the intervention package because either they were not willing when the project was initiated or they were beyond the reach of the project have started to ask to be accommodated in the program. The coordinator also affirmed that greater demand was coming to the organization from the community to be beneficiaries of the program.

The intervention helped beneficiaries to become free from exploitation by illegal 'money lenders.' According to the respondents, money lenders are people who borrow money with high interest for individuals in need of it. Before MKC-RDA's intervention and brought the idea of saving, people used to borrow money from money lenders with interest rates up to 100%, making themselves richer, while the rest of the community was getting poorer and poorer.

The respondents (both the interviewees and focus group discussion participants) have said that their economy was getting better and better because of the intervention. As the facilitator respondent said, beneficiaries were encouraged to discuss their practices about resource management, focusing on financial issues. For the FAL groups to start saving, they were allowed to reflect on their economic status, existing practices in the community focusing on their money lending or borrowing practices, and how their status would be changed. Why saving, strategies of saving, administration of financial matters, and the like were the key points for discussion. Discussants of the focus group reported that members of FAL groups were adults who would decide on their own; they discussed and decided the amount of money they wanted to deposit per week. Based on the information obtained from the program coordinator, almost all FAL groups were taking part in saving. For the sake of illustration, one FAL group from each Kebele was taken

randomly and shown below in the following table:

Table 3. shows the amount of money saved by randomly selected FAL groups within two years

Name of the FAL group	Total number of members	Amount saved (in Ethiopian Birr)
Sena Guddina (Dano Center: Osole Kebele)	20	11,240.00
Abdi Wakayyo (saritti Daku Kebele)	23	25,700.00
Misoma Abdi Wakayyo (Kolu Galan Kebele)	16	31,207.00
Jalane (Bicho Kebele)	15	11,010.00
Abdi Boru (Chalalaka Warabulch center: Boni Jawe Kebele)	21	11,358.00

As has been depicted in the above table, members of FAL groups and the amount of savings were not the same. The income, commitment, and creativity of households of different FAL groups might not be the same. One of the points respondents predominantly talked about during interviews and focus group discussions held with the beneficiaries was the fact that FAL groups employed different strategies to increase their savings. They were engaged in different kinds of income-generating activities that, of course, called for entrepreneurship skills. According to FGD participants, "FAL groups have agreed not to deposit money rather each group member was encouraged to borrow money and invested it with modest interest (on average 6%), either personally or in groups." This helped the group members to be critical and engaged in different kinds of entrepreneurial activities that helped them to increase the income of the respective households and the savings of the FAL groups.

The process of borrowing and lending money was another episode where active learning and sharing of experience occurred. The FAL groups have their respective committees that were in charge of managing the finances. The committee was also responsible for providing advisory services and follow-up activities. As the facilitator reported, "For an individual or group of individuals to borrow money from their association, they were expected to come up with their business plan." The feasibility of the business plans was scrutinized by the committee and other members of the FAL groups who were relatively experienced. On top of that, constant follow-up and supervision were conducted if the money borrowed was used for the intended purpose.

Picture 1: Indicate how saving is related with different aspects of livelihood

Beneficiaries' literacy skills and the extent of utilization of the skill

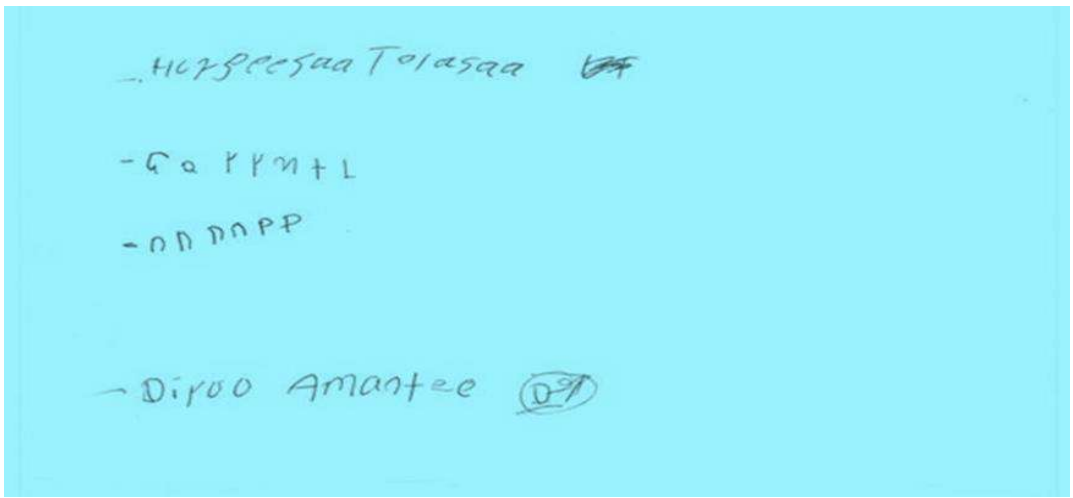
Based on the information obtained from the coordinator, the frequency of the meetings of FAL groups to attend literacy class was not the same as has been discussed in the table below.

Table 4. Literacy class per week based on the data obtained from the MKC-RDA program coordinator's office

	Frequency of meeting to attend literacy class per week	No.	%
1	Five days	31	23.7
2	Three days	50	38.5
3	Two days	40	30.5
4	One day	10	7.3

Table 4 depicts that 23.7 % (31) of FAL groups met five days per week, 38.2% (50) of them met three days per week, 30.5% (40) of them attended literacy classes twice per week, while 7.3% (10) of FAL groups were engaged only once per week in literacy activity. This happened to be the case because attending literacy classes was purely a voluntary activity, and the decision was made by the beneficiaries themselves.

Based on the information obtained from the facilitator respondent, "the ability to read and write varies within individual members of the FAL groups." Some of the participants could not read and write. Some others were found to be semi-literate in that they read and write with some degree of difficulty, while others have acquired the skills sufficiently and have started to use them in their day-to-day activities. To verify the information provided by the interviewee, beneficiaries were randomly selected and invited to write their name in Afan Oromo (Oromo Language) and sign. Two of the participants have managed to write their names in a fairly good manner, while the other two have failed to do so as has been displayed here under.



FAL groups were encouraged to take part in literacy classes using different strategies. Among other things, "all members are required to hold the leadership position in their respective FAL group turn by turn which requires literacy skills", the program coordinator replied. Thus, members of FAL groups were challenged to take advantage of literacy classes for their own good. Those who became literate were keeping the financial

records of the FAL groups, such as monthly members' contributions, money borrowed and collected from members, and other related information. On top of that, one of the FGD members said "I have started to assist my children's schooling activity." In conclusion, those who can read and write with understanding were utilizing their literacy skill in their day-to-day activities.

Issues of concern as discussed by stakeholders

Based on the information obtained from the center office coordinator situated in the study area, it was learned that 11 facilitators were assigned to serve about 2434 beneficiaries who were organized into 131 FAL groups. From the data, it is possible to infer that the facilitators-beneficiary ratio was 1:221. On the other hand, it is also possible to see that 1 facilitator is expected to serve about 12 FAL groups, which were quite large, and that might hurt the effectiveness of the program.

Firstly, learners would not get enough support from facilitators because they can hardly satisfy the needs and interests of different FAL groups. Secondly, facilitators would be overburdened with huge responsibility, which in turn might lead them to frustration. Thirdly, it would be difficult to execute administrative tasks effectively and provide timely feedback.

As the MKC-RDA coordinator reported, the Woreda Education Bureau was not providing supervisory support and failed to arrange a forum to share experiences with similar institutions engaged in similar tasks, even if the bureau had been invited formally. Had organizations working in the area of FAL created strong links, it would have been possible to share the experience, and the effectiveness of the approach would have been scrutinized and scaled up.

Conclusion

The intervention of MKC-RDA to enhance the livelihood of the community in five Kebeles of Jeldu Woreda using FAL as an approach helped to improve members' saving activity and to create their capital. The FAL group served as a credit-giving association for members with fair interest rates, and members had equal opportunity to borrow money as individuals or groups of individuals, which saved members from 'money lenders.' The creation of capital also brought about increased aspirations for growth. Most of the beneficiaries were engaged in different kinds of income-generating activities which helped them to inculcate entrepreneurship skills. Though the intervention was found to be generally successful, participants did not get enough support because the number of facilitators and beneficiaries was not proportional.

Recommendations

From the findings of the study, the following tentative recommendations have been made, which could improve the intervention of MKC-RDA. Further research is required to test if these recommendations apply to the wider program.

1. As the study confirmed, the intervention strategy employed by the organization was unique and exemplary. The organization sees the beneficiaries as capable, knowledgeable, and have experience that counts. It is highly recommendable if the strategy is scaled up at the national level and the experience is shared with different governmental and non-governmental organizations, including religious institutions.

2. The findings also revealed that the number of facilitators is not enough as compared to the number of beneficiaries. Indeed, it is wise to create a mechanism for how to tackle the problem. The researcher believes that there is a possibility of making use of beneficiaries so that they can serve as co-facilitators. Initiating and building up the culture of volunteerism could be another strategy that can be used to come up with the solution to the mentioned problem.

3. It has also been seen that the organization was using different strategies to encourage

participants to take advantage of literacy classes. But, as has been observed good numbers of participants were still illiterate. Thus, the organization needs to exert extraordinary effort to create awareness and prove the advantage of being literate to improve one's livelihood.

4. Though the organization has had cooperation and good relationships with governmental organizations, little effort has been made to get supervisory service from the Woreda Education Office. To learn from others and share one's own experience, it is wise to get supervisory service.

5. To make the intervention more meaningful and rewarding, facilitators played a very crucial role. In order to discharge their duties and responsibilities effectively, they need to be acquainted with the subject matter and methodology. Thus, the organization needs to arrange different kinds of tailor-made training to capacitate facilitators so that they can serve the purpose at their level best.

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