Value chain analysis of Mung Bean (*Vigna radiata* L. Wilczek thrive) in Kalu Woreda, Ethiopia

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Abstract

Background: Mung bean is an important pulse legume multipurpose crop that has significant health and economic benefits. It plays an important role in climate resilience and increasing food security. We conducted the study in Kalu Woreda Eastern Amhara, Ethiopia, where the crop is highly adopted. The study aimed to analyse and evaluate the local value chain of the crop. Though Mung bean is a market oriented crop and playing an important role in food and nutrition security; there is a lack of clear evidence that shows how the local value chain of the crop is performing. Therefore, empirical evidence on the Mung bean value chain is required to design interventions to enhance the value chain actors' performance.

Methods: A mixed approach was used to collect and analyse the data and to have a complete picture of the research. We collected data from producers, collectors, wholesalers, retailers, and exporters through household survey, focus group discussion and key informant interviews. Descriptive statistics and econometric model were used to analyse the quantitative data. We analysed qualitative data using narration, summarization, and theme formation.

Results and conclusion: The average allocated land for Mung bean per household was 0.32 ha with a standard deviation of 0.15 ha. Mung bean value chain actors include input suppliers, producers, collectors, retailers, wholesalers, exporter and consumers. The highest percentage of the profit share goes to exporters (25.04%), followed by wholesalers (21.61%). Traditional farming practices, small landholding, poor access to agricultural inputs, pests and disease, poor infrastructure, and price fluctuations were the major Mung bean production and marketing challenges. Sex 0.166 ($P = 0.008$), the volume of Mung bean produced 0.26 (0.0001), farming experience 0.028 (0.048), frequency of extension contact 0.01 (0.072) and land allocated for Mung bean 3.411 (0.0001) were significantly determining the amount of Mung bean supplied to the market. Supporting farmers with agricultural inputs and delivering training on post-harvest issue, experience sharing among producers, and linking producers to cooperatives looks important to develop Mung bean local value chain. Strengthening multi-stakeholder linkages among Mung bean value chain actors through field days and workshops is also imperative in smoothing the local and international marketability of the crop.

Keywords: Actors, Mung bean, Profit margin, Value chain analysis, Kalu Woreda

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Background of the study

Mung bean (*Vigna radiata* L.) is one of the most important pulse legume crop, grown between an altitude of 5 to 1600 meter above the sea level [1, 2]. It has multiple economic, social and environmental benefits and grown across the globe (Africa, South America, Australia, and

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Asia) [3]. Depending on the variety, it has a short maturity period (60–90 days) [4]. The crop has also climate smart nature with wide adaptability, low water requirement, and the ability to improve the soil by fixing atmospheric nitrogen [5].

Mung bean has premium quality over other legume crops as it is more palatable, highly nutritive, and easily digestible crop and it is an excellent source of carbohydrates (51%), protein (24–26%), minerals (4%), and vitamins (3%) [6–8].

Ethiopia is known as the homeland of several crops [9]. It is ranked 13th among pulse producing countries in the world. With annual area coverage and volume of production, Mung bean is ranked sixth with 41,633.3 ha and 514,227.4 Quintal, respectively [10]. The Ethiopian national average productivity of Mung bean is 0.9 t/ha, which is 20% lower than the global average (1.2 t/ha) [8, 9]. Mung bean becomes the sixth commodity to be traded on the Ethiopian commodity exchange since 2014. For example, Ethiopia has earned from Mung bean export 12,229,321.06 USD from 02-Jan-2020 to 16-Jan-2020. The top recipient countries were Indonesia, Vietnam and Portugal.

Even though there is high productivity potential and high demand for the crop in the global market, there is smuggling and illegal trade, low coordination of value chain actors and low awareness of consumers to include it in their local dish [3, 9]. It is used as a source of cash income for smallholder farmers, where 75–90% of their production is directly supplied to the market. However, there are different production and value chain challenges including low and unstable yield, erratic rainfall, the prevalence of pests and diseases, lack of input supply, lack of proper storage and handling, low level of local consumption and demand, asymmetry of market information, inappropriate and poorly developed market chain, price impulsiveness, low market promotion, lack of stakeholder's commitment, and lack of finance [2].

Previous literatures in the study area such as ([11], were much focused on agronomic practices and production factors. However, Mohammed et al. [2] studied the value chain of Mung bean in North Shewa, Ethiopia and they focused more on the production and market challenges using qualitative approaches. Yet, the determinants of marketable supply of the crop in the value chain have been little studied. The crop is new to the international market and there is no inclusive and well-developed value chain [4]. Since 2014, the marketing of the crop passes mainly through the ECX market channels. However, because of poor quality standards, a significant proportion of the product supplied by local farmers is rejected from the international market system by ECX. The product rejected by the market system is exposed to post-harvest losses. The perishability nature of the crop and its poor integration into the local food system also play a significant role for the crop loss.

There are various theoretical approaches employed in the value chain studies, of which the linkage, Filiere, and Porter approaches are the most cited [12–14]. Our study prefers the Filiere's value chain approach, which encompassed empirical perspectives which are used to map the flow of commodities and to identify actors and activities. Porter used the holistic approaches to include all the firm's activities to design, produce, market, deliver and support its product [15]. In this context, special attention was given to the process of the local production systems, marketing, and its linkage to the industries, trade, export, and final consumption. Therefore, this study aimed to identify the mung bean value chain actors and their function, to examine actors' performance along the value chain, to explore major constraints and opportunities of mung bean production and marketing and to analyse the determinants of the quantity of mung bean supplied to the market in the study area.

Research methods

Study area

We conducted the study in Kalu Woreda, South Wollo Zone, Ethiopia. It is located 376 km away from Addis Ababa, 494.2 km far from the regional city, Bahirdar. Based on land suitability analysis (LSA), by different development projects, Kalu Woreda is suitable for mung bean production and it is one of the three mung bean production and market centre in the country [4].

The Woreda is divided in to 30 rural and 5 urban Kebeles (the lowest administrative unit in Ethiopia). The climatic condition of the Woreda varies from dry sub-humid to semi-arid with the annual average rainfall range of 750 to 900 mm. The altitude of the Woreda ranges from 800 masl in the lowlands bordering the Oromia Zone to 1750 masl at the foot of the mountains north of the Kombolcha town. The annual temperature of the area is between 25 and 30 °C. Based on [16], the Woreda has a projected population of 215,337, of which 49.5% were female and 86.4% of them are rural dwellers. With an area of 851.54 square kilometres, Kalu Woreda has a population density of 244.58 persons per square kilometre. The Woreda has 27,454 ha arable land. The major crops grown in this Woreda are sorghum, teff, vegetables, haricot bean, chickpea, mung bean and maize during Meher (the main cropping season from June to October) and Belg (A short rainy season normally beginning in February and ending (depending on the area) in late April/May). The soil types in the Woreda are predominantly sandy loamy and the Woreda is characterized by a subsistence mixed farming system in which the production

of both crops and livestock is common economic activities. Major constraints of the farming systems in the Woreda include low soil fertility, terminal moisture stress, crop pests and diseases, shortage of improved varieties, inappropriate cropping practice (mono-cropping), and inappropriate land preparation. Land pressure is also another bottleneck for crop production in the area. Similarly, seasonal feed shortage, animal diseases and parasites, low performance of local breeds, and short supply of improved forage seed are major constraints for livestock production. There are important mung bean market centres in the Woreda, such as Gerba, Harbu, Ancharo, and Degan. However, poor market infrastructure hinders their performance and the mung bean marketing in the Woreda is more of traditional (Fig. 1).

Methods of data collection

Due to time and budget constraints plus the relative importance of the Woreda for the crop, the researchers collected data from Kalu Woreda mung bean producer farmers. It is hypothesized that producer farmers in the Woreda could have rich information as several government and non-government actors (Sirinka Agricultural Research centre, ECX, BENEFIR-REALISE project and ARDA) were intervening in the area to promote Mung

bean production and productivity through improved seed system, and well-developed market. We collected data from randomly selected farmers (among mung bean producers), and purposely selected wholesalers, collectors, retailers, and exporters of the crop. Actors who were taking part in the mung bean market for at least 5 years were considered for the research. We collected qualitative data using key informant interviews and focus group discussions. We held four focus group discussions using a predetermined interview guide, and we interviewed 15 key informants from Producers, the Woreda trade and agriculture office and the Ethiopian Commodity Exchange office (five interviewees from each). A structured questionnaire was used to conduct a household survey with selected farmers and traders. About 23 Mung bean traders were interviewed from Degan, Harbu, and Kombolcha market centres.

Sample size and sampling procedures

For this study, we drew the samples from all actors involved along the mung bean value chains. We used a three stages sampling procedure for the selection of sample household heads. In the first stage, we selected Kalu Woreda purposively based on high mung bean productivity and being one of the mung bean collection centres

Fig. 1 Map of the study area

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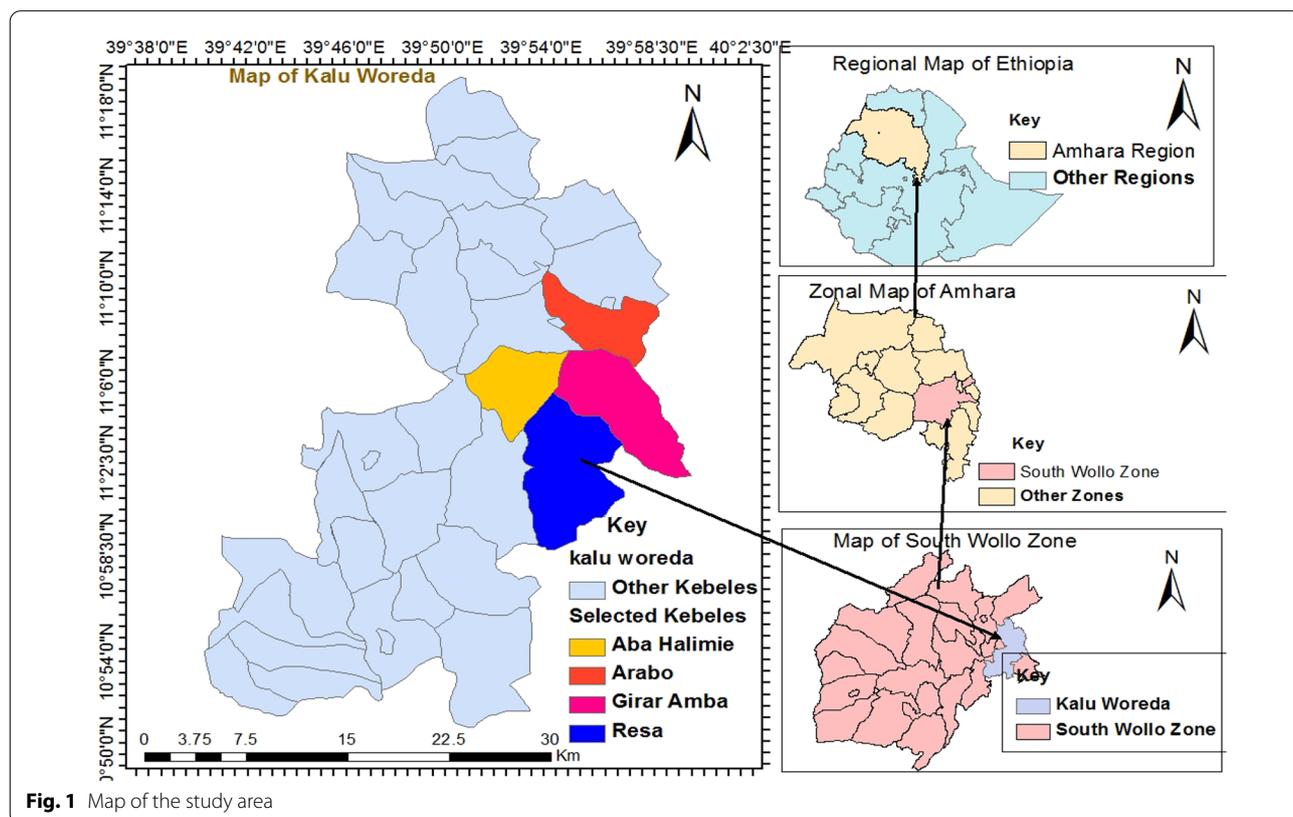
in the country. In the second stage, four Kebeles were randomly selected out of the nine mung bean producer Kebeles of the Woreda. Last, 379 sample household heads were selected randomly using probability proportional to size (PPS) among 7150 mung bean producers in the Woreda. The actual sample size was determined using Yemane [17] sampling formula. Since the population is finite, Yemane's formula was used to determine the required sample size at a 95% confidence level with a degree of variability of 5% and a 5% level of precision [17]. Therefore, the sample size is calculated as

$$n = N \Big/ 1 + N(e)^2 \sim n = \frac{7150}{1 + 7150(0.05)^2} = 379$$
(1)

where n = sample size, N = population size, and e = level of precision (Table 1).

Representatives of wholesalers, rural collectors, exporter, and retailers from the specified market were selected systematically based on their level of influence in the chain and their experiences. We considered those who have 5 and more years of experience in the market during the data collection. As a result, 23 Mung bean traders (10 rural collectors, 6 retailers, 5 wholesalers, and 2 exporters) were included from Harbu, Degan, and Kombolcha local mung bean market centres.

Methods of data analysis
Mixed methods of data analysis techniques were used to accomplish the objectives of the study and to have a complete result.

Qualitative analysis
We analysed qualitative data using narrative analysis, content analysis and thematic analysis. Through this approach, the researchers identified mung bean value chain actors, their respective roles, major constraints, and opportunities for mung bean production and marketing in the area.

Descriptive analysis
Descriptive analyses were used to analyse respondent's socio-economic characteristics and actor's performance along the value chain.

Marketing margin
As Mendoza [18] argued, when there are several participants in the marketing chain, the margin is calculated by finding the price variations at different segments and then comparing them with the final price to the consumer. The consumer price is then the base or the common denominator for all marketing margins. Computing the total gross marketing margin (TGMM) is always related to the final price, or the price paid by the end consumer and expressed as a percentage. It was useful to introduce here the idea of farmers' share or producers' gross marketing margin (GMM) which is the proportion of the price paid by a consumer that belongs to the producer. Producer act as a middleman also receives an additional marketing margin:

$$\text{TGMM} = \frac{\text{final consumer price} - \text{producer price}}{\text{final concumer price}} * 100$$
(2)

where TGMM is total gross marketing margin. Whereas (GMM) which is the producer's share in consumer price could be calculated as GMM = 1 − TGMM. On the other hand,

$$\text{GMM} = \frac{\text{consumer price} + \text{seller price}}{\text{concumer price}} * 100.$$
(3)

The above equation tells us that a higher marketing margin diminishes producers' share and vice versa. It also provides an indication of welfare distribution among production and market agents [19].

Model specification
Several value chain studies have used OLS to analyse the determinants of the marketable supplies of different market oriented commodities [16–18].

Some cereals and legumes crop may be produced solely for home consumption without considering the market supply. However, Mung bean is produced for the market purpose. Thus, all producers are either fully or partly involved in the market orientation. Therefore, to identify the factors that affect the volume of Mung bean supply to the market, a multiple linear regression model is appropriate [20]. Hence, all farmers who engaged in the Mung bean production practice are expected to supply their production, either whole or some to the market. Accordingly, this study used OLS

Table 1 Distribution of sampled households across Kebeles

No	Sample kebeles	No of Mung bean producer	No of sampled respondent
1	Resa	408	135
2	Aba hilmie	206	68
3	Arabo	230	76
4	Grar amba	301	100
Total		1145	379

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model to analyse the factors that affect the volume of mung bean supply to the market.

The dependent variable is the amount of mung bean supplied to the market, which is a continuous variable. We specified the model as;

$Y_i = F$ (Sex of household head, non-farm income, family size, amount of credit, size of land allocated for mung bean, lagged market price of mung bean, total livestock holding, farming experience, frequency of extension contact, distance from the nearest market, Education level of household head, and mung bean productivity). The multiple leaner regression model is specified as follows:

$$Y_i = X_\beta + U_i$$

where Y_i = quantity of Mung bean supplied to the market (in quintal per year); β = a vector of estimated coefficients of the explanatory variables; X = a vector of explanatory variables; and U_i = disturbance term.

Before fitting the model to the data, we checked the multicollinearity among the explanatory variables using the Variance Inflation Factor (VIF). As a rule of thumb, if the VIF is greater than 10, the variable is said to be highly collinear [20]. The VIF for all explanatory variables is less than 10 (1.06–2.13), which shows that there is no multicollinearity problem among explanatory variables included in the model estimation.

Variables of the study and their expected outcome

The dependent variable of the study was the mung bean quantity supplied to the market and measured in quintal during the production year of 2018/2019. We presented independent variables of the study and their expected outcome under Table 2.

Results and discussion

In this section, value chain analysis of Mung bean, which includes the value chain map, actors, marketing channels, margins, and performance of actors along the value chain, are discussed. The value chain governance, challenges and opportunities among the value chain are also assessed.

Socio-economic characteristics of the respondents

Out of 379 Mung bean producers, 73.7% were male-headed and 26.1% were female-headed households. The result also showed that 83.7% were married. The survey result also showed that 38.9% of the sampled household heads could not read and write. 42.2% of respondents have attended informal religious education (such as learning Quran and Bible) which enables them to read, write and understand the written message given by extension agents or others. However, 16.3% and 0.5% of the households attended primary and secondary school, respectively. Certificate holders made up the smallest proportion of producers. The minimum and maximum age of the respondents was 25 and 68 years, respectively, with a mean age of 42.12 years. The average family size of the farmers was 3.48, with a standard deviation of 1.26 and a maximum family size was 8 (Table 3). One of the most important factors that influence crop production

Table 2 Summary of variables and expected outcome

Notation	Definition of Independent Variable	Type	Measurement	Expected out sign
FSZ	Family size	Continuous	Man equivalent	+ ve
EDH	Educational status of the house hold	Categorical	1 = not read and write 2 = read and write 3 = primary (1–8) 4 = secondary (9–10) 5 = certificate and above	+ ve
EXPER	Farming experience	Continuous	Years	+ ve
NOFI	Non-farm income	Continuous	Amount of birr the farmer earned other than farming activity	− ve
LMP	Lagged market price	Continuous	Birr per quintal	+ ve
AOC	Amount of credit	Continuous	Birr/year	+ ve
SEX	Sex of the house hold	Dummy	0 = female 1 = male	+ ve
SLH	Size of land allocated for Mung bean	Continuous	Hectare	+ ve
TLU	Livestock holding	Continuous	Tropical livestock unit	+ ve
FOEC	Frequency of extension contact	Continuous	Number of day contact	
DSNM	Distance to nearest market	Continuous	Walking in hours	− ve
MNBP	Mung bean productivity	Continuous	Quintal per hectare	+ ve

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Table 3 Socio-economic characteristics of respondents

Variable	Frequency	Percent
Sex		
Male	280	73.7
Female	99	26.1
Total	379	100
Single	5	1.3
Marital status		
Married	318	83.7
Divorced	44	11.6
Widowed	12	3.2
Total	379	100
Education		
Not read and write	148	39.05
Religious education	160	42.2
Primary	62	16.3
Secondary	2	0.005
Certificate and above	7	0.018
Total	379	100

Variable	Minimum	Maximum	Mean	Std. deviation
Age	25	68	42.12	7.7
Family size	1	8	3.48	1.26
Owned land (ha)	0.25	3	0.8080	0.27807
Rented in land (ha)		0.25	0.333	0.2856
Rented out land (ha)		0.5	0.0020	0.02868
Shared in land (ha)		0.25	0.0053	0.03598
Shared out land		0.5	0.0066	0.05712
Grazing land		0.5	0.1624	0.13225
Total land holding to Mung bean production	0.13	1	0.3219	0.14921
Tropical livestock unit		9.41	4.1678	1.89237

Source own survey, 2020

is resource endowment, specifically the availability of land for crop production. The survey highlights that the average land size owned by the sample households was 0.8 hectares with a standard deviation of 0.28 hectares and the average allocated land for Mung bean per household was 0.32 hectares with a standard deviation of 0.15 and ranges from 0.13 to 1 hectare during the survey year (Table 3).

Mung bean value chain actors and their performance

The chief actors involved in the Mung bean value chain, and their role and interrelationship are discussed below.

Input suppliers

In our study, Cooperatives, Bureau of Agriculture (BoA), traders, and Ethiopian Commodity Exchange (ECX) are the main input suppliers within the Mung bean value chain. There is also an informal supply of inputs such as seeds, fertilizer, pesticides, and farm implements through farmers to farmer exchange. Adequacy and quality of Mung bean seeds are crucial for increased production. Sampled producers were asked whether they were used improved input or not. The largest proportion of producers (91.8%) uses improved input. The major source of agricultural input supply was the Woreda's office of agriculture (61.6%). In a nutshell, government is the main input supplier for small holder Mung bean producer and the role of private sector and other actors is still minimal (Table 4).

The labor employed in Mung bean production from land preparation to harvesting is described and identified that about 94.7% of the respondents used family labor, 1.2% of the respondent used hired labor and 3.7% of the respondent used labor exchange locally known as "wonfel" for the production of Mung bean (Table 4). Similarly, one of the Mung bean producing farmers stated that:

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Table 4 Source of agricultural input and its application on Mung bean production

	Frequency	Percent
Do you use agricultural input?		
Yes	349	91.8
No	29	8.2
Source of inputs		
NGOs	44	11.6
Cooperatives	102	26.8
Agriculture office	233	61.6
Types of labor used		
Family labor	360	94.7
Hired labor	7	1.2
Exchange labor	12	3.7

Source: own survey, 2020

"I have seven young family members. They helped me in the entire process of the Mung bean production. So I did not need any external labor force".

The production of Mung bean using family labor, which is usually unpaid, shows that the production of Mung bean in the area is small scale and can easily be managed by the household itself.

Producer/farmer

Farmers are the primary and most important actors in the mung bean value chain. They took part both in the production and marketing of the crop they produced. Considering the resources, a farmer may decide what input to use, when to seed and harvest, how much to consume, and to sell. They perform most of the value chain activities right from farm inputs preparation on their farms to post-harvest handling and marketing. The major value chain functions Mung bean producers perform include land preparation, growing/planting/, weeding, pest/disease control, harvesting, and post-harvest handling and marketing. Almost all Mung bean producer farmers in the study area produced Mung bean using a rain feed farming system. As stated in Fig. 2, 335 (88.4%), of Mung bean producers used the sole cropping system. Most farmers grow Mung bean for generating cash than consumption in their food system. It is also highlighted that there is limited knowledge and expertise on how to use Mung bean in their dish as food.

Collectors/local assemblers

Rural collectors are independent operators at the primary local markets who assemble and transport the Mung bean from smallholder farmers either directly (home to home), or in the local market centres. They used packed animals and mini trucks (small commercial vehicles) for

Fig. 2 Mung bean cropping system in Percentage. Source: Own articulation, 2020
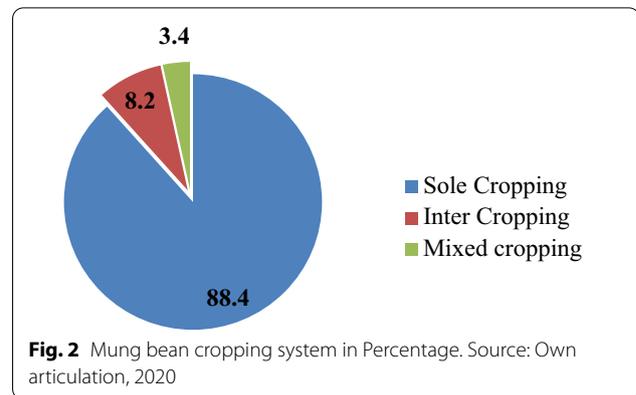
transporting to wholesalers. The local traders play the key role in the Mung bean value chain as suppliers for the wholesalers. Their roles in the trading activities include buying and assembling, repacking, and selling. Most of these actors own or rent storage at the local level (local town) but rarely store over 2 or 3 days. These local traders collect Mung bean and supply for the wholesalers, and the wholesalers purchase the product both from the rural collectors (local traders) and producers.

"... Producers of Mung bean sold their production at their home to rural collectors when the producers are far from the marketplace."

Key informant interviewee

Retailer (local)

Retailers are key actors in the Mung bean value chain. They mostly perform the last marketing function by linking consumers with other traders and/or producers. In our interview result, we found that they had limited purchasing and product handling capacity because of lack of finance, transportation, and storage facilities. They sold Mung bean in Degan, Kombolcha, and Harbu market centres during the market and other days. We also observed that retailers sell a small amount of Mung bean (our market visit). Retailers have less profit advantage than wholesalers as the product is export oriented and the local consumers are few.

Wholesalers

Wholesalers are large-scale traders who mostly buy Mung bean from rural collectors and sometimes directly from farmers. Wholesalers are the major buyers of Mung bean who buy at least a truckload of Mung bean from producers/farmers. Most of them have official trade licenses and unlicensed wholesalers also operate irregularly during the time of production. Wholesalers used local agents to collect the product from the producers.

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They have better storage, transport, and communication facilities than other value chain actors in the area. The interview result shows that wholesalers had more Mung bean trading capacity with higher market influence and profit shares.

> *We had a link with the national market via ECX, and we bought higher volume of Mung bean than other actors in the value chain. Suppliers and producers from different directions brought us the crop.*

Key informant interviewee, whole seller

Exporters

They are traders who purchase and export Mung bean to the international market. According to the survey result, there were few private exporters engaged in purchasing Mung bean from retailers and passed through the Ethiopian commodity exchange market platform. The Interview from ECX agents shows that the main importing countries of Mung bean are European and Asian countries, such as Portugal, Netherlands, Turkey, Greece, Italy, Belgium, India, Pakistan, Indonesia, UAE and China. However, the challenge is inferior quality product. For instance, 28.4% of Mung bean that comes to ECX was rejected because of quality standards set by ECX in 2018/19 production season. The main quality parameters include Color, which will be green and shining (Dark green and shining); odor (preserve the original nature of the crop (free from any bad, toxic and overuse of chemicals). Safe transportation and non-use of dispatches, free from live insects, maintain standardized moisture content, free from any physical damages and free from immaturity (grade shrinking seeds) are also other ECX parameters for the crop. Thus, higher percentage of foreign matters, physical defect, moisture level (over 13%), mixed color, and unfamiliar odor lead to rejection of the product. However, there was a lack of knowledge and poor awareness about those parameters among the producers. There was also poor coordination among stakeholders and value chain actors.

> *The product requires extreme quality to meet the international quality standards. The ECX rejects unfit products, and returned to the producers. Each year significant amount of the product loss occurs because of inferior quality and poor marketability.*

FGD participant (ECX agent)

Enablers and facilitators

In a value chain, enablers include all chain-specific actors providing a regular support services, and represent the common interest of the value chain actors. The supporting function players for the Mung bean value chain were those who did not directly relate to the Mung bean product holders but gives support to the value chain actors. The support functions include research and development (universities and research centres), infrastructure, and information. Support service providers were essential for value chain development and include sector-specific input and equipment suppliers, financial services (specifically, Amhara credit and saving institute), extension service, and market information access and dissemination, technology suppliers, advisory service, etc. In the study areas, there are many institutions supporting the Mung bean value chain. The common service providers were the Woreda Agriculture and Rural Development Office, the Woreda Trade and Market Development Office, Cooperatives, Private transporters, and the Ethiopia Commodity Exchange (ECX). Some service providers provide multiple functions and others are limited to a specific function. The local government provides input and agricultural extension services such as advisory services, facilitates access to inputs, and provides technical support in agronomic practices and post-harvest handling. However, the current performance of the government extension service is not adequate to bring the desired outcome. This result highlights that there is a need for the involvement of private sectors in the extension service provision activities. The value chain map and supporters' activity are presented in Fig. 3.

The local value chain map of Mung bean

Mapping a value chain expedites a clear understanding of the sequence and integration of activities, key actors, and relationships involved in the value chain. Major functions of actors include input supply, production, collection, retailing, trading, whole-selling, and export. Figure 3 depicts the value chain functions, the actor of the value chain, and service providers' role. Consumers are considered as the end-users. Commercial Bank of Ethiopia, ACSI, local agricultural office, cooperatives, and Agro-dealers were service providers. Money flows from consumer to retailer, wholesaler, collector, producer, or exporters. Products flow from producer to retailer, collector, wholesaler, and exporter. Information flows in one direction, usually from wholesaler to rural collector, wholesaler to producer, international market to the exporter, and exporter to the rural collector. Exporters and ECX agents exchange information each other.

Value chain governance

The study result showed that exporters and wholesalers assisted by brokers were the key value chain governors. According to our FGD result, the producers' position in the price negotiation and determination was very weak. This was due to lack of accurate

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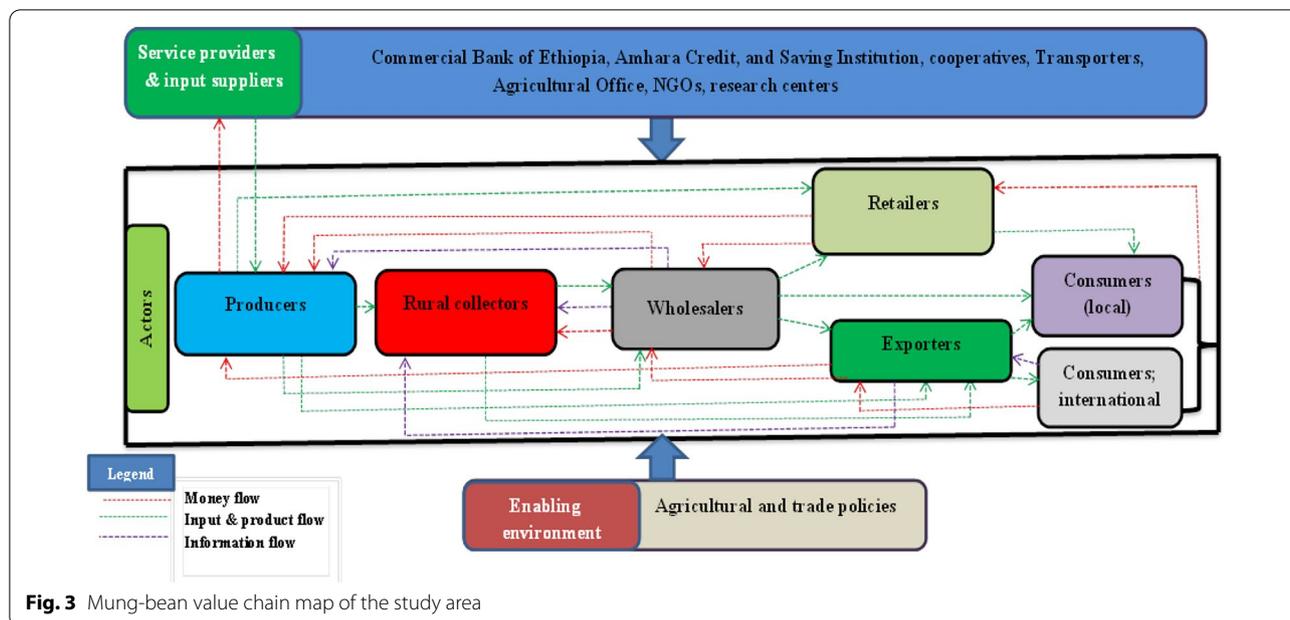
Fig. 3 Mung-bean value chain map of the study area

market information and poor producer's bargaining power because of absence of producers' associations. Farmers/producers were not price setters and price cutters. Producers reported that there was no equal access to information across chain actors and asymmetry of information in the value chain affects their decision in their production and marketing processes. Our study assessment showed that the brokers assisted the wholesalers to seize the advantages over Mung bean producers' and the local governance structure exercised was favourable to wholesalers and retailers and place other actors in a weak position. Wholesalers have sufficient information about the supply of the crop and they dominate the channel. They exchange information on Mung bean prices, local supply situation, and production projection in the area. They set the price of the crop considering their profit margins. Except for this networking and business relation, there is no formal collateral when the transaction takes place. The actor's power imbalance within the crop value chain results a weak coordination among them.

Marketing channels and marketing margin
We used marketing channel and marketing margins in the analysis of supply chain performance. Producers sell Mung bean through different channels. According to the study result, we identified 6 main outlet channels in terms of the quantity of Mung bean flow in to the end users. We estimated that 649 quintals of Mung bean were supplied to the market by sampled farmers during the

study period. Wholesalers and collectors were the main receivers of the Mung bean with percentage shares of 63.75% and 31.25%, respectively.

As stated in Fig. 4, there are six market channels identified during the survey period. The highest share of Mung bean is supplied through the Producer–wholesaler–exporter channel with 60.5% share, while the lowest share of Mung bean is supplied through producer–collector–retailer–consumer channel. It accounted for 0.7% of the total Mung bean marketed with 4.56 quintals of the product. The result leads to a conclusion that the crop is produced mainly for commercial purpose.

Mung bean marketing cost and margin analysis
Margin fortitude surveys should be conducted corresponding to channel surveys based on the price of selling to calculate the margin. We estimated marketing costs to compute the share of profit captured by key actors in the marketing chain. The highest marketing cost was incurred by the exporter (51.68 birr/qt.) followed by the wholesaler (31.78 birr/qt.). Exporters' transport costs were higher to send the product to the exporting country and an average production cost of producers was (855 birr/qt.) (Table 5).

The marketing margin refers to the difference between selling prices at different levels in the marketing system. The analysis of marketing channels should provide systematic knowledge of the flow of goods and services from their origin of production to the final destination. Actors incurred marketing costs for transportation, storage, sorting, packing, cleaning, loading, commission,

Fig. 4 Mung-bean market channel in Kalu Woreda, Ethiopia. Source: Own sketch, 2020
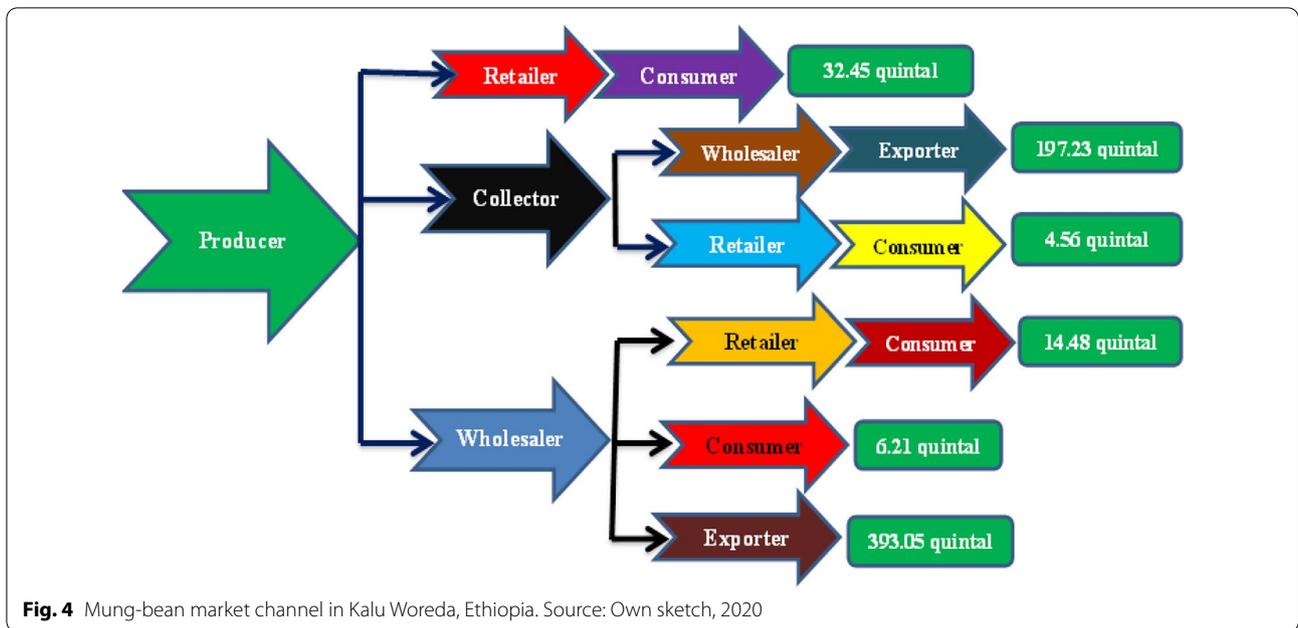
Table 5 Marketing margin and gross profit of actors in Mung bean value chain

Cost Items (ETB/qt)	Actors					
	Producer	Collector	Wholesaler	Retailer	Exporter	Sum
Purchasing price	–	1700	1800	1750	2500	7750
Production cost	855	–	–	–	–	
Marketing cost						
Load/unload	1.5	2.5	3	1.5	4.5	
Labor for packing cost	1.3	2.5	4.25	0.25	4.5	
Cost of sack	10	10	8	9	7	
Transport	2.5	1.2	1.98	0.75	5.6	
Storage	1.25	2	2	0.5	6.4	
Telephone cost	1	2.25	1.85	1.5	4.2	
Personal expense cost	3.4	0.5	0.25	2.15	3.12	
Tax	–	1.25	2.35	2.5	3.25	
Commission fee for broker	–	1.25	1.35	1.57	4.4	
Employer salary	2.5	2.46	3.5	0.25	3.5	
Other cost	3.25	2.1	3.25	1	5.21	
Total marketing cost	26.7	28.01	31.78	20.97	51.68	
Total cost	881.7	1728.01	1831.78	1770.9	2551.68	8764
Selling price	1600	2300	2650	2500	3500	12,550
Marketing margin	745	600	850	750	1000	3945
Percentage share of margin	18.88%	15.29%	21.54%	19.01%	25.34%	100%
Profit margin	718.3	571.99	818.22	729.03	948.32	3785.9
Percentage share of profit	18.98%	15.10%	21.61%	19.26%	25.04%	100

Source: own computation survey result, 2020

taxes, and others. Production costs, such as seeds, fertilizers, agrochemicals, land, Labor, and oxen, were also computed for producers. As most of the households used their own family labor and its opportunity cost, oxen, and land related costs were used to compute the costs of production.

The average cost of Mung bean production for a sample household was 855 birr/quintal. Based on the production costs and purchasing prices of the major market participants along the chain, margins were computed for producers, rural collectors, wholesalers, retailers, and exporters.

Constraints and opportunities of Mung bean value chain

There were several constraints and opportunities for Mung bean production and marketing as explained by different actors through FGD and key informant interviews. The main hampering problems for the Mung bean value chain were categorized into three basic levels: at farmers', marketing/traders and the consumers' stage.

At the farm-level there are shortage of improved and good quality seed, high cost of inputs, shortage of adequate pesticides/herbicides, small landholding, limited knowledge on agronomic practices, poor harvesting and post-harvest handling, diseases and pest infestation, and lack of awareness on Mung bean food preparation. The high cost of inputs and lack of access to improved varieties were the most important challenges for Mung bean production. Disease (such as Mung bean yellow mosaic virus) and insects were among production-related problems. The other problems with Mung bean marketing and processing with corresponding opportunities are presented in Table 6. The quality problems occur during the production and harvesting of the crop, which was related to poor wedding and poor post-harvest management. There is improper quality management of crop production in the study area, which results in the product's

inability to fulfil the export quality standards. There is high production and export growth of Mung bean in the last few years. However, its contribution to improving nutrition status, income, and export earnings is limited. It is reported that the use of improved Mung bean varieties and best agricultural practices (use of good quality seed, sowing, ploughing, fertilizer, inter-cropping/double cropping, weeding, pesticide, etc.) were fickle across producers.

According to a key informant interview from the National Pulse Research Program there are challenges related to limited availability of improved varieties, quality and quantity of seeds, low soil fertility, rainfall variability, disease and pest, limited use of improved crop management practices, post-harvest loss, and market price fluctuation. Key areas of improvement should include investing in introducing new high-yielding varieties, establishing quality seed multiplication, strengthening the Mung bean extension system, and promote value addition activities for the crop.

Determinants of volume of Mung bean supplied to the market

Prior to running multiple linear regressions (OLS), we checked the hypothesized explanatory variables for the existence of multicollinearity, heteroscedasticity, and endogeneity problems.

As depicted from the econometric result under Table 7, we included a total of 12 hypothesized explanatory variables in the model to explain the household level determinants of the market supply of Mung bean. Among these

Table 6 Summary of challenges and opportunities of Mung bean production and marketing

Stages	Constraint	Opportunities
Input supply	Shortage of quality seed, Farm implements and Inconsistent input access	Higher demand of seed chemical and Local material availability for organic compost preparation
Farm/production	Disease and pest attack	Good production condition (air)
	Limited knowledge on recommended agronomic practice	Good policy environment for export crops
	Lack of training for Mung bean production	Low labour required (less labour intensive production system)
Market	Seasonal price (inconsistence)	Establishment of exporter via ECX
	Transportation problem	Good support from government
	Distance market	Higher demand of Mung bean by international market
	Forgery scaling or weighting	
	Higher influence of brokers	
	Limited function of cooperative	
	Absence of market research	
Processing	Lack of processing technologies	Emerging involvement of private sector in the food system industry
	Limited awareness on Mung bean processing	
Consumer	Low income Lack of awareness about Mung bean for nutritional values	Increase in nutrition knowledge of urban consumers

Source: own summery, 2020

Table 7 Determinants of Mung bean marketed supply (OLS result)

Variable	Co ef	Std. Err	t value	P > t
Sex of households head	0.166***	0.062	2.66	0.008
Family size	0.017	0.017	1.02	0.309
Education	0.011	0.026	0.41	0.68
Extension contact	0.01*	0.006	1.8	0.072
Farming experience	0.028**	0.014	1.99	0.048
Amount of credit	0.000	0.000	0.79	0.433
Land allocated for Mung bean	3.411***	0.167	20.37	0.000
Distance to nearest market	−0.028	0.018	−1.58	0.114
Productivity of Mung bean	0.26***	0.01	25.64	0.000
Total livestock holding	0.018	0.011	1.58	0.115
Lag market price	0.015	0.016	0.97	0.332
Non farming income	0.000	0.000	−1.5	0.134
Constant	−1.463	0.134	−10.92	0.000
Number of observations				379
R-squared				0.80
Adjusted R-squared				0.79

Source: own computation, 2020

*, ** and *** represents significance level at 10%, 5% and 1%, respectively, levels

variables, sex of household head, frequency of extension contact, land allocated for Mung bean production, farming experience, and productivity of Mung bean per hectare had a positive relationship to the marketable supply of Mung bean.

Sex of households head being male-headed household significantly increases the Mung bean quantity supplied to the market by 0.166 Quintals as compared to that of female-headed households.

Land allocated for Mung bean as expected, the size of the farmland allocated for Mung bean was found to have a positive and significant effect on the amount of Mung bean supplied to the market. Based on the result, a 1-ha increase in the farm size allocated for Mung bean increases the supply of the crop to the market by 3.4 quintals. The likely explanation for the positive association is that the production of Mung bean will increase with an increase in land allocated to Mung bean.

Farming experience As the farming experience of producers increases by 1 year, the marketable supply of Mung bean to the market increases by 2.8%. It is believed that more experienced farmers may have better knowledge, experience and capital accumulation that are important for the production and marketing of Mung bean. They may also have better market information with efficient use of resources.

Frequency of extension contact Agricultural extension services provide information, ideas, organization and input to boost surplus production. As hypothesized, the number of extension visit has a positive and significant impact in increasing the marketable supply of Mung bean. It is found that the marketable supply of Mung bean increases by 1% as the frequency of extension contact increases by 1 day.

Productivity of Mung bean as the productivity of Mung bean increases by 1 quintal, the marketable supply of Mung bean to the market increases by 26%.

Discussion

Enhancing a sustainable market for multipurpose crops such as Mung bean has multiple economic and environmental benefits for the communities. Mung bean is a protein rich crop with high soil health contributions [3, 21, 22]. Our findings showed that almost all farmers in the study area produce Mung bean in their farm and about 0.32 ha of land is allocated to Mung bean production, which is by far lower than 3.9 ha in Uzbekistan [23]. Although it is produced as a common crop in the study area, the market integration is still fragmented and not in the favour of the smallholder farmers. This is in contrast with the findings of [24] which shows "*producers and processors received the highest profit margin*" in sesame value chain. Large farmers in the study area produce Mung bean for aiming for cash than including their local food consumption. Because of this, rejection of the crop from the ECX lead international market and poor integration into the local food system are considered as major challenges of the value chain. Other Mung bean producer countries consume a significant amount of their production in their daily food. For example, on average, households consumed 8.7 g/capita/day in Pakistan and 7.3 g/capita/day in Uzbekistan as estimated from a 7 day recall [23]. In connection with the findings of [2], our study also confirmed that the key production and marketing challenges of the Mung bean includes erratic rainfall, prevalence of pests and diseases, lack of input supply, low level of local consumption, lack of proper storage and handling, inappropriate market chain, lack of market information, price impulsiveness, and poor stakeholders commitments..

Several factors affect the marketable supply of Mung bean to the market. We observed significant variation among men and women farmers in the study area, where men were supplying more volume of the crop to the market than their women counterparts. This may be because of male-headed households have better resource availability required for the production and better access to market information than female-headed households. Similarly, Mahlet et al. [25] and Shafi et al. [26] also confirmed sex of the household head positively and significantly influenced the haricot bean and Papaya volume of marketable supply in eastern Oromia, Ethiopia.

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The area of land allocated for Mung bean has also shown positive and significant effect on the volume of Mung bean supplied to the market. Farmers who produce more usually supplied high volume to the market. This might be associated with the crop is mainly cash crop and market dependent. It is also confirmed by Gebremedhn et al. [24] and Aysheshm [27] when the amount of land allocated for sesame production is increased it had positive effect to farm level marketable supply of sesame, in northern Ethiopia.

Similar to our finding, Mahlet et al. [25], Tadesse [28] and Abraham [29] showed that farming experience had a positive and significant relationship with a marketable supply of different commodity crops including vegetable crops. Productivity of the Mung bean, and better extension contact showed a positive effect on the volume of market supply of Mung bean. This has similar views with the result of [27]. He identified that the productivity (yield) of Sesame determines its marketable supply. In addition, [25, 30–32] have similar finding in other crops.

Conclusions and policy implications

Six different Mung bean value chain actors were firmly involved in the value chain of the crop. Mung bean is supplied to the end-users through six market channels. Wholesalers assisted by ECX are the main Mung bean value chain governors, and they receive a great share of Mung bean in the market. The highest share of profit goes to exporters, retailers, wholesalers, and collectors in descending order. The producer's position in price negotiation and product quality definition were not competitive. ECX still rejects a significant amount of Mung bean produced because of poor quality standards that fit the export market requirements. The productivity of Mung bean per hectare, sex of the household head, farming experience, frequency of extension contact, and size of land allocated for Mung bean production significantly and positively determine the quantity of Mung bean supplied to the market. As a policy implication, strengthening the producers' bargaining power through training and direct support of their local institutions (farmer cooperatives and saving associations) seems more important. To improve the quality of Mung bean produced, strengthening the bond between extension workers and producers, increasing farmers' education level, provision of training and sharing of experiences among all value chain actors is required. Moreover, integration of Mung bean crop to the local food system could facilitate the value addition practices on the crop.

Abbreviations

ACSI: Amhara Credit and Saving Institution; BLUE: Best linear unbiased estimator; CLRM: Classical linear regression model; CSA: Central Statistical Agency; ETB: Ethiopian birr; ECX: Ethiopian commodity exchange; FAO: Food and Agricultural Organization; FGD: Focus group discussion; GMM: Gross marketing margin; KWARDO: Kalu Woreda Agriculture and Rural Development Office; PPS: Probability proportional to size; GMMp: Producers' gross margin profit; Qt: Quintal; RMA: Rapid market appraisal; TGMM: Total gross marketing margin.

Declarations

Ethical approval and consent to participate
Ethical clearance letter and permission were got from the Rural Development Agricultural Extension Department and Woreda administration and agricultural offices. Verbal consent was obtained from every participant. They were also informed about the aim of the study, and the information obtained was kept confidential.

Consent for publication
The manuscript to be submitted to this journal has been approved by the authors. The authors would declare that the manuscript had neither been submitted nor published in other journals.

Competing interests
The authors declare that they have no competing interests.

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References
1. Achakzai AKK, Panizai MK. Effect of row spacing on growth, yield and yield components of mashbean. J Hortic. 2007;23(1):149–55.
2. Mohammed A, Muhammed S, Said M. Marketing practices and challenges of Mung bean in Ethiopia Amhara Regional State: North Shewa Zone in focus. African J Mark Manag. 2017;9(4):35–45. https://doi.org/10.5897/ajmm2015.0454.
3. Ali MZ, Khan MAA, Rahaman AKMM, Ahmed M, Ahsan AFMS. Study on seed quality and performance of some Mung bean varieties in Pakistan. Int J Expt Agric. 2010;1(2):10–5.
4. Ameda TT, Diro M, Teshome A, Tadesse A. Experience of experience of realise. In: Diro TTM, Tefera T, Vonk R, Diro M, Teshome A, Vonk R, Ambaye A, Teshome A, Gebremariam G, editors. Innovations for food and

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livelihood and livelihood security. Wageningen University & Research: Wageningen; 2021.

5. Habibzadeh Y, Moosavi Y. The effects of water deficit stress on protein yield of Mung bean genotypes. Peak J Agric Sci. 2014;2(3):30–35. https://www.peakjournals.org/sub-journals-PJAS.html

6. Mogotsi KK. Vigna radiata (L.) R. Wilczek. In: Brink M, Belay G, editors. Wageningen: PROTA (Plant Resources of Tropical Africa/Ressources végétales de l'Afrique tropicale); 2006. https://www.prota4u.org/database/protav8.asp?h=M4&t=Vigna,radiata&p=Vigna+radiata#Synonyms

7. Islam MR, Kamal MM, Alam MA, Hossain J, Soufan W, Skalicky M, Brestic M, Habib-Ur-rahman M, Sabagh AEL, Islam MS. Physiochemical changes of Mung bean [*Vigna radiata* (L.) R. wilczek] in responses to varying irrigation regimes. Horticulturae. 2021. https://doi.org/10.3390/horticulturae7120565.

8. Afzal MA, Abdul Hamid MA, Bakr A, Sarker W, Erskine MH, Smith-Anthony M. 2004. Technology dissemination to boost pulse production and human nutrition in Bangladesh. 4th International Crop Science Congress: Bangladish.

9. Dessie AB, Abate TM, Mekie TM, Liyew YM. Crop diversification analysis on red pepper dominated smallholder farming system: evidence from Northwest Ethiopia. Ecol Process. 2019;8(1):1–11. https://doi.org/10.1186/s13717-019-0203-7.

10. FDRECSA. The Federal Democratic Republic of Ethiopia Central Statistical Agency Report on Area and Production of Crops. In the federal democratic republic of ethiopia central statistical agency; 2018 (Issue April 2018).

11. Birhanu A, Tadesse T, Tadesse D. Effect of inter- and intra-row spacing on yield and yield components of mung bean (*Vigna radiata* L.) under rain-fed condition at Metema District, Northwestern Ethiopia. Agric Food Secur. 2018;7(1):1–7. https://doi.org/10.1186/s40066-018-0234-9.

12. Ayelech T. 2011. Market chain analysis of fruits for Gomma Woreda, Jimma Zone, Oromia National Regional State, MSc thesis Haramaya University,Haramaya Ethiopia.

13. Porter ME. Competitive advantage of nations creating and sustaining superior performance. New York: Simon and schuster; 2011.

14. Liang Q, Li L, Bai R. Welfare effects of vegetable producers' inclusiveness in supply chain coordination: direct effects and spillovers. British Food J. 2021;123(4):1305–23. https://doi.org/10.1108/BFJ-07-2020-0652.

15. Reji EM. Value chains and small enterprise development: theory and praxis. Am J Ind Bus Manag. 2013. https://doi.org/10.4236/ajibm.2013.31004.

16. Central Statistical Agency. Population projection of Ethiopia for all regions at wereda level from 2014–2017. J Ethnobiol Ethnomed. 2013;3(1):28.

17. Yemane, T. Statistics: An Introductory Analysis. 2nd Edition, New York: Harper and Row; 1967. https://www.sciepub.com/reference/180098

18. Mendoza G. 1995. A primer on marketing channels and margins. In: GJ.Scott, Gregory J. Scott, editors. Prices, products, and people analyzing agricultural markets in developing countries. Lynne Reinner Publishers: Boulder

19. Slangen LHG. Book reviews. European Review of Agric Econ. 1982;9(4):483–4. https://doi.org/10.1093/erae/9.4.483.

20. Corlett WJ, Aigner DJ. Basic Econometrics. Econ J. 1972. https://doi.org/10.2307/2230043.

21. Acciani C, BoniDe A, Bozzo F. Pulses for healthy and sustainable food systems the effect of origin on market price. Sustainability. 2021. https://doi.org/10.3390/su13010185.

22. Kassa Y, Mamo D, Abie A, Tigabe A, Ayele T. Scaling up of improved mung bean technology in the potential areas. Int J Agric Ext. 2021;09(02):135–41. https://doi.org/10.33687/ijae.009.02.3257.

23. Jouan J, Ridier A. Economic drivers of legume production: approached via opportunity costs and transaction costs. Sustainability. 2019;2017:1–14. https://doi.org/10.3390/su11030705.

24. Gebremedhn MB, Tessema W, Gebre GG, Mawcha T, Assefa MK, Gebremedhn MB, Tessema W, Gebre GG. Value chain analysis of sesame (*Sesamum indicum* L.) in Humera district Tigray Ethiopia. Cogent Food Agric. 2019. https://doi.org/10.1080/23311932.2019.1705741.

25. Mahlet A, Bezabih E, Mengistu K, Jeffreyson KM, Jemal Y. Gender role in market supply of potato in Eastern Hararghe Zone Ethiopia. African J Agric Mark. 2015;3(8):241–51.

26. Shafi T, Zemedu L, Geta E. Market chain analysis of papaya (Carica papaya): the case of Dugda District, Eastern Shewa Zone, Oromia National Regional State of Ethiopia. J Agric Econ Dev. 2014;3(8):120–30.

27. Kindie A. Sesame market chain analysis: the case of Metema Woreda, North Gondar Zone, Amhara National Regional State. A Thesis Submitted to the Faculty of the Department of Agricultural Economics, School of Graduate Studies, Haramaya University; 2007.

28. Tadesse A. Market chain analysis of fruits for Gomma Woreda, Jimma Zone, Oromia National Regional State [Haramaya University]. In Phys. Rev. E. 2011. http://ridum.umanizales.edu.co:8080/jspui/bitstream/6789/377/4/Muñoz_Zapata_Adriana_Patricia_Artículo_2011.pdf

29. Abraham T. Value chain analysis of vegetables : the case of Habro And Kombolcha, M.Sc. Thesis, Haramaya University, Haramaya Ethiopia [Haramaya University]. 2013. https://www.academia.edu/32829465/VALUE_CHAIN_ANALYSIS_OF_VEGETABLES_THE_CASE_OF_HABRO_AND_KOMBOLCHA_WOREDAS_IN_OROMIA_REGION

30. Ayelech T. 2011b. Market chain analysis of fruits for gomma woreda, Jimma Zone, Oromia national regional state, MSc Thesis Haramaya University,Haramaya Ethiopia. Phys. Rev. E. 110.

31. Teka AG. Analysis of fruit and vegetable market chains in Alamata, Southern Zone of Tigray: the case of onion, tomato and papaya. Gatineau, Quebec: Canadian International Development Agency; 2009.

32. Rehima M, Dawit A. Red pepper marketing in Siltie and Alaba in SNNPRS of Ethiopia: factors affecting households' marketed pepper. Int Res J Agric Sci Soil Sci. 2012;2(6):261–266

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