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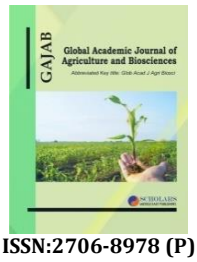

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Review Article

Mung Bean (*Vigna radiata L.*) Production Status and Challenges in Ethiopia

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Abstract: Mung bean is one of the most important pulse crops, grown from the tropical to sub-tropical areas around the world. Mung bean has good potential for crop rotation system, for crops under drier farmland cultivation areas and ability of growing on dry and irrigated conditions. Mung bean has considerable importance in economical, food, fodder and agricultural (green manure crop to improve soil fertility) aspects. Sowing of mung bean mainly occurs during summer when sufficient rain is available for growth but it is sensitive to waterlogging. It is grown in several types of cultivation systems, including sole cropping, intercropping, multiple cropping and relay cropping, where it is planted after cereals using residual moisture. Mung bean accounts insufficient amount of cultivation practice for food and fodder. Mung bean has considerable importance in economical, food, fodder and agricultural (green manure crop to improve soil fertility) aspects. The huge constraints of pulse crop value-chain production, aggregation and trading, and demand sinks/export. Productivity is below potential due to low input usage, especially chemical fertilizers inability to increase yields, limited availability of seed, limited familiarity with the variety of existing seed types, and limited usage of modern agronomic practices. The link between the producers and the export markets is weak, due to the large number of ineffective intermediaries operating in the value chain. The fragmentation of intermediaries between the producer and consumer markets creates a lack of transparency in markets. We have to support the farmers with recommended agronomic packages, we have to protect disease and insect pest, improved varieties, recommended fertilizer should be applied for better grain yield production of mung bean.

Keywords: Agronomic management, fertilizer application, Mung bean, production potential and varieties.

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INTRODUCTION

Mung bean is in Amharic known as "*Masho*" and it is a recent introduction in the Ethiopian pulse production and grown in few areas of the country. Mung bean is a warm season annual legume which is a drought resistant crop with an optimum temperature range of 27- 30°C for good production. It is very early maturing quick crop, requiring 75–90 days to mature. Best adaptation areas for Mung bean are at 1,000-1,650 meters above sea elevation level; with annual rainfall of 600-750mm, its production in Ethiopia is most suited with clay loam fluvsol, clay eutric fluvisol, and pellic vertisol types of soil. It is

usually sown at "*Belge*" lean season between Februarys to April and "*Mehere*" between Julys to August when the rain starts to end. Mung bean productivity in Ethiopia is estimated to be on average from 12 up to 15 Qt ha^{-1} with a volume of production is increasing year to year. Amhara and Benishangul Gumuz regions are the two potential production areas of green Mung bean. In Ethiopia, the green grams do well in the lowland areas. This is because they require 6-8 hours of sunlight per day, and thrive in well-drained areas hence loam-sandy soils and a pH of 6-7. Although they don't need much water, they need to be watered during the blooming period to avoid disappointing yield.

Although green Mung bean is commonly used in some other countries, it is little consumed in Ethiopia even by those who produce it. The volume of production is also very small and it is concentrated mainly in North Shewa and South Wollo zones of Amhara region and in some woredas of Benishalgul Gumuz region (ECX, 2021). It is only produced as a cash crop to generate income by selling it to exporters. The regional agricultural bureaus and market actors estimate that close to 90% of the total production is marketable surplus.

In 2015/2016, Ethiopia exported a total of 30,694 metric tonnes (MT) of green Mung bean with a value of 35.8 million USD. The comparison of export performance of to 2014/2015, the export volume and value grew up by 21% and 23%, respectively (ECX, 2014). The major export destinations for Ethiopian green Mung bean are: Indonesia, India, Belgium, UAE, and Singapore. The other major global players in Mung bean import comprises: USA, Netherlands, UK, Canada, France, Germany, Norway, Sweden, and Malaysia. Green Mung bean price is significant from year to year, for example in 2014/2015 the average FOB export price per MT was about $USD 1,211but in 2015/2016 the price per MT declined to $USD 1,211 but increased by 26% in 2013/14. Besides, the local price of green mung bean varies significantly from the lean season to harvesting season (ECX, 2018). Since mung bean is an important pulse crop for smallholders that have recently gained attention and announced as the sixth export commodity by Ethiopian Commodity Exchange (ECX, 2014). The farmers and other out growers are economically advantageous by producing mung bean. They sell the grain of mung bean with high value in Ethiopian local market. We have to support with technology to the farmers and other investors. Therefore, in this review tried to assess the marketing practices and challenges of cash crops with due emphasis on Mung bean, emerging commodity in ECX market. So, the production status, constraint and potential of mung bean should be accessed and evaluated.

Mung Bean Production Ethiopia

Cropping System

Mung bean in Ethiopia can be grown either as a single crop (mono-cropping), rely cropping or as an intercrop (mixed cropping) with other crops by small scale farmers. The most common intercrops involve mung bean with sorghum, maize, coffee and other fruit crops like avocado. When it is to be grown in rotation, it should be followed by a cereal crop such as sorghum, maize, wheat, rice, tef and barley. It is grown in several types of cultivation systems, including sole cropping, intercropping, multiple cropping and relay cropping, where it is planted after cereals using residual moisture (Rehman *et al.,* 2009).

Mung bean (*Vigna radiata* (L.) Wilczek) is an important pulse crop in Asia because of its high protein content and ability to improve soil fertility (Asim *et al*., 2016). In Thailand, it is widely cultivated and occupied a cultivated area of 143,931 ha with the production of 102,799 ton of grain in 2009 (Ibedo, 2014). In Uganda, it is widely grown by smallholder farmers in the eastern and northern regions of the country (Ibedo, 2014). The genus Vigna has been broadened to embrace about 150 species; twenty-two species are indigenous to India and sixteen to Southeast Asia, but the principal number of species are originated in Africa (Mogotsi, 2006). Mung bean is an annual food legume belonging to the sub genus Ceratotropis in the genus Vigna. It is the seed of Phaseolus radiates L. and an annual herb of the Leguminosae family. It has green skin and is also called green bean. It is sweet in flavour and cold in nature (EPP, 2004). Mung bean (*Vigna radiata* L.), a member of the Fabaceae family, is a tropical legume. It is a warm season annual, highly branched and having trifoliate leaves with plants varying from one to five feet in length (Puranik *et al*., 2011). Intercropping is the practice of growing two or more crops together in a single field. The experimental results of Wondimkun (2022) the highest grain yield mung bean (18.54 Quintal/ha) was obtained from when mung rely intercropped with 100% population density and 1:3 row arrangements. The grain yield of mung bean was significantly affected by cropping system at Sankura wereda jejebicho kebele (Wondimkun, 2022). He reported that the highest grain yield (16.48quntal/ha and 17.42qutal/ha) was obtained from sole cropping of mung bean at 2019 and 2020 cropping seasons respectively. Grain yield of mung bean was higher from sole cropping than the intercropped (Akanda and Quayyam, 1982, Kalra and Gangwar, 1980, Akhtaruzzaman, 1987). According the experimental founding of Khan *et al*., (2012) number of pods $plant^{-1}$ of mung bean directly influences grain yield of it.

Intercropping of cereal crops with grain legumes is a widespread focus for current research in Ethiopia as it increases farm income and reduces pressure on land resources (Kebede, 2020). The experimental results of Degaga and Angasu (2017) further indicated that intercropping is very important for the intensification of crop production and contributes to increased returns to smallholder farmers having a limited land holding. Moreover, intercropping offers higher yield than sole cropping, greater yield stability, more efficient use of nutrients, better weed control, provision of insurance against total crop failure and improved quality by variety (Matusso *et al*., 2014). Intercropping of cereal crops with legumes is the most farmers prefer practice (legumes as intercrops with carbohydrate-rich staple food crops such as maize (*Zea mays* L) and sorghum (*Sorghum bicolor L*)).

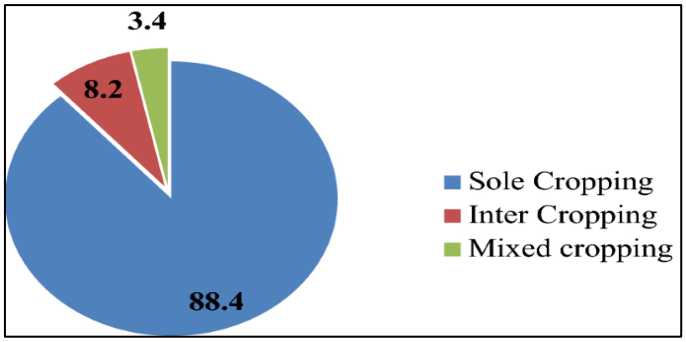

Figure 1: Mung bean cropping system in Percentage. of mung bean in Ethiopia
Source: Assefa *et al*., 2022

The two types of cropping system were commonly implemented by the respondent these are sole cropping and intercropping systems. From the study areas Amhara, Oromia and SNNP regions farmers used both intercropping and sole cropping system. As result from informants, purpose of intercropping practice is to manage two or more crops simultaneously. For mung bean intercropping with different crops applied by local farmers were for the purpose of enhance soil fertility and gain more than one crop at particular time.

Crop Rotation System of Mung bean with other crops increases both land and crop productivity particularly and is important for sustainable agriculture. Annual crop legumes grown in rotation with cereals contribute to total amount of nitrogen in the soil and improved yield of cereals (Ahmad *et al*., 2001). But some rotation systems can be problematic. For example, poor soil physical conditions limit successful cropping of mung bean after rice. If seeds are sown too early after rice harvest, anaerobic conditions may reduce crop establishment and decrease yield potential (Kirchhof and So, 2005). As it is a short duration legume, it is mainly cultivated between rice-rice, rice-wheat, rice-potato- wheat, maize- wheat, cotton, and other cash crop to increase both land and crop productivity (Ebert, 2014). Adaptation to short growth duration, low water requirement, ability to increase soil fertility and usefulness in crop rotation practices are also other significances of mung bean (Das *et al*., 2014).

Production Potential of Mung in Ethiopia

The farmers are producing mung bean during *belg* season and through irrigation around Shewarobit North Shewa Amhara Ethiopia. The experimental results of Habte, (2018), revealed that maximum grain yield of Mung bean was 786.8kg/ha which was harvested from Borada research canter of west hararge of Ethiopia. The experimental results of Mohammed *et al.,* (2015), reported that 150,000 to 200,000 quintals of Mung bean, is produced per year in Ethiopia. It is one of the countries of east Africa severing from drought because of climate change with high prevalence of food security. However, despite of its multi-dimensional importance of very little attention has been paid to its productivity improvement in the country. Dry land areas are experiencing low agricultural yields due to severe water shortages and salinity, leading to food scarcity. Mung bean is gaining attention as a short-season crop that can tolerate dry land conditions, and fix atmospheric nitrogen, decreasing soil nutrient depletion. Moreover, the yield gap in relative to the Asian countries suggests that there is a potential for increasing production and productivity of smallholder specially for green mung bean farmers. Ethiopia gifted various agro ecological zones and diversified natural resources, which has been known as the home land and domestication of several crop plants. Mung bean is an important component of crop produced in Ethiopia's smallholder's agriculture, providing an economic advantage to small farm holdings as an alternative source of income. It plays, an important role in the export sector generating foreign currency for the

country. Mung bean production at the country level is no considerable improvement in quantity as well as quality of production to provide it for the central market with the help of Ethiopia commodity exchange (ECX).

Table 1: Description of Released mung bean varieties in Ethiopia

	Varieties					
Characteristics	**MH-97-6 (Boreda)**	**Rasa (N-26)**	**Shewarobit**	**NVL-1**	**Arkebe**	**Chinese**
Altitude (m.a.s.l.)	550-1780	900–1,670	900–1,670	450–1,650	600–1000	450–1,650
Rain fall (mm)		350–550	350–550	350–750	400–800	350–750
P_2O_5 rate (kg ha^{-1})	46	46	46	46	46	46
N rate (kg ha^{-1})	18	18	18	18	18	18
Maturity days	70-90	65–80	75–90	60–70	60–68	75–90
Yield on research (kg ha^{-1})	935.33-1143.27	800–1,500	800–1,500	750–1,500	1955–2526	750–1,500
Yield on farmer (kg ha^{-1})	6500-1,000	500–1,000	500–1,000	500–1,000	----------	500–1,000
Year of release		2011	2011	2014	2014	
Breeder		MARC	MARC	MARC	Humera	Registered

Source: (MoA 2011; MoA 2014; Kassa *et al*., 2023)

Figure 2: Mung bean field performance Silte zone of Ethiopia in 2019/2020 cropping season

Figure 3: Mung bean field performance at Ziway (Batu) area 2019/20 cropping seasons

The productivity of mung bean is low in Ethiopia compared to the production reported in other countries around the globe, which might be attributed to low soil fertility, which is also attributed to the limited use of inorganic fertilizer (Fekadu *et al*., 2021). There were several constraints and opportunities for Mung bean production and marketing as explained by different actors through

Focus Group Discussion (FGD) and key informant interviews (Assefa *et al*., 2022). 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 (Assefa *et al*., 2022).

Major Constraints of Mung Bean Production in Ethiopia

The main challenge that Ethiopian farmers face in producing mung beans is unpredictable rainfall since mung bean productivity is highly dependent on the amount and distribution of rain. The other critical challenge is pests and diseases, affecting the yield and quality of mung beans. Apart from salinity and heat stress, water deficit and waterlogging are also the key abiotic stresses that restrict growth, development and yield traits in mung bean. Lack of improved variety of mung bean the productivity of has a great impact on its grain yield, so the crop's yield remains low. The most important determinants were the use of local varieties and the lack of improved high-yielding cultivars, as well as the inadequate or non-application of inorganic fertilizers. The challenges of climate change in plant production are discussed, and how progress in mung bean breeding and the application of improved cultivation techniques.

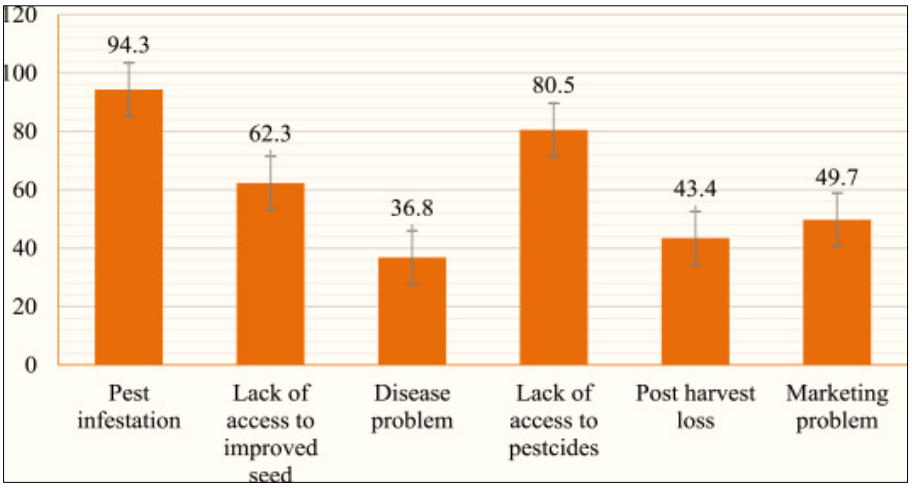

Figure 4: Major constraints of mung bean production
Source: Kassa *et al*., 2023

Effects of Rain Fall

The amount and distribution of rain fall has a significant effect for mung bean production. Mung bean doesn't need rain fall at physiological maturity; however, it needs less amount rain at vegetative stage. The amount of rain required to produce mung beans is lower than the minimum precipitation requirement for other crops. However, rainfall amounts and distribution are irregular and sometimes unfavourable for mung bean production. Sowing of mung bean mainly occurs during summer when sufficient rain is available for growth but it is sensitive to waterlogging.

Prevalence of Pests and Diseases

The occurrence of pests and diseases is also another critical challenge of mung bean production. The severity of pests and insects is occurred when the availability of pesticides and insecticide is limited. So, the accessibility of pest sites significantly affects the production of this crop in the production area. Further they noted that the negative impact of pest and disease in the zone is lower than the impact of unpredictable rainfall. Likewise, the discussant noted, for the time being, pest and other related crop diseases are to be a potential problem of mung bean production. In this respect, the expertise disclosed that most of the time farmers do not use pesticides as well as other protective mechanisms to prevent the negative impacts of pests and diseases associated with producing the Mung bean. Since mung bean is a new emerging commodity crop in Ethiopia there a lack of pesticide access and has no pesticide control awareness for farmers. The pod-boring weevil *Apion clavipes* Gerst is also economically an important pest of the mung bean, causing a yield loss of over 60 percent (Worku and Azerefegne, 2019). Hence, the occurrence of such

crop pests and diseases would affect the productivity and quality of Mung bean.

Lack of Input Supply and other Management

The production of crops is highly contingent on improved inputs like seed, fertilizer, row sowing and other recommended agronomic practice. However, agricultural research institutes made minimal efforts to enhance commodity varieties, particularly mung beans. Mung bean and other pulse crops has taken a marginal resources like fertilizer, agronomic and crop management. The mung bean varieties can vary in terms of their blended NPS fertilizer requirement (Baza *et al.*, 2022). They also reported that, overall improvement in, yield determining traits such as number of pods per plant, seeds per pod and 100-seed weight resulted in higher grain yield with the highest blended NPS fertilizer rate (150 kg ha^{-1}) requirement (Baza *et al.*, 2022).

Shattering and Lack of Proper Post-Harvest Handling

Harvesting management practices determine quality and quantity of the crop. Harvesting of mung bean by farmers was done when crop plant became mature. Early sowed of landraces mung bean were harvested at the beginning of October while late was harvested during November based on maturation and sowing times of the crop. Mung bean is very sensitive for shattering and harvesting maturity. It is essential to focus on improving post-harvest activities such as collecting, storage, and handling to improve mung beans' grain quality. This, in turn, helps farmers have substantial bargaining power in the market and better market returns. It has a perennial fruiting nature and has no uniform maturity time. Its cultivation time ranges between June to July and harvesting was done from October to November based on maturity of the crop.

Effects of Nitrogen and Phosphorus on Mung Bean Production

The research technologies of Mug bean are nationally coordinated by Melkasa Agricultural research center and regional research's Amhara research institute, south research institute. Nitrogen containing fertilizers are essential for crops as source of proteins and play beneficial roles on crop performance, which contribute for maximizing production (Davis and Brick, 2009). It is a high value industrial pulse crops in Ethiopia. These experiment results Wondimkun and Hailu (2022) which revealed that the highest grain yield of mung bean was obtained from the maximum Phosphorus rate (60kg ha^{-1}) and 40cmx10cm intra row spacing at Jejebicho research station of Wondo Genet Agricultural Research Center and at Ziway farmers field of Eastern Shewa of Oromia. They also recommended that 60 kg P_2O_5 ha^{-1} with 40cmx10cm intra row spacing is best and economical to mung production for farmers in the mid to low land parts of Ethiopia. The experimental results of different findings concluded that application of optimum rate of blended NPS fertilizer along with best performing mung bean varieties can boast of high grain yield of mung bean and income to the farmers. The farmers have a backward attitude for the application of fertilizers for mung bean production in Ethiopian. Fertilizers like, Nitrogen is an important mineral whose nutritional management requires special attention due to its diverse roles in plant physiology and metabolites biosynthesis, as well as its dynamics in soil (Noroozlo *et al*., 2019, Mohammadipour and Souri, 2019, Souri *et al*., 2018). Mung beans require more nitrogen in the reproductive stage than in the vegetative stage. Phosphorus is the second most important phytonutrient in crop production after N. Phosphorus deficiency is exacerbated under dryland conditions, which affect fertilizer efficiency and successful crop production (Jan *et al*., 2012). Sulphur promotes the formation of legume nodules and stimulates the production of seeds. With the application of S up to 20 kg ha^{-1}, the total number of nodules and active nodules increased significantly (Ganeshamurthy *et al.*, 2000). Application of phosphorus with other micronutrients can increase the production. Generally, P fertilizer is applied as a starter fertilizer before planting. Application of P can enhance root growth, improving flower formation and seed production (Havlin and Beaton, 2004). The most commonly used fertilizers in Ethiopia were N and P, but they are not the only yield constraining elements. For instance, sulfur (S) is recently identified to be low in most soils (ATA, 2015). Therefore, S is among the sixteen essential elements, which are important for many reactions and functions in all living cells and the fourth major nutrient, following NPK (ATA, 2015). The soil fertility map of the study area showed that levels of N, P, K, S, and Zn, as well as elements such as B and Cu, are depleted, and deficiency symptoms are observed in major crops (EthioSIS, 2015).

Marketing System and Value Chain

The market system of mung bean grain is started from small farmers. This supply does not pass directly from producer to the final consumer. Rather it is separated from the demand of consumers in time, place, form and size of the product. Marketing is the performance of business activities that direct the flows of goods and services from the producer to consumers. The major market participants identified in Mung bean marketing in different local market of Ethiopia are producers, local assemblers, wholesalers, brokers and retailers. Small holder producers are the only suppliers of mung bean, so there are no large-scale farms in the

regions producing this commodity. First buyers the so-called farm traders are the main buyers of the grain in the country side. Trading is a part time job for the purpose of gaining additional source of income. Assemblers play an important role in the marketing system by pushing up the produce from the remote rural surplus markets to the towns, deficit areas and urban centers where the produce is demanded (Ahmed *et al.,* 2017). Wholesalers are the central figure in the market channel; this means the wholesalers of the given commodity are involved in wholesale trade, rarely selling directly to consumers. However, mung bean marketing, in the area the job of wholesalers and retailers is mixed up.

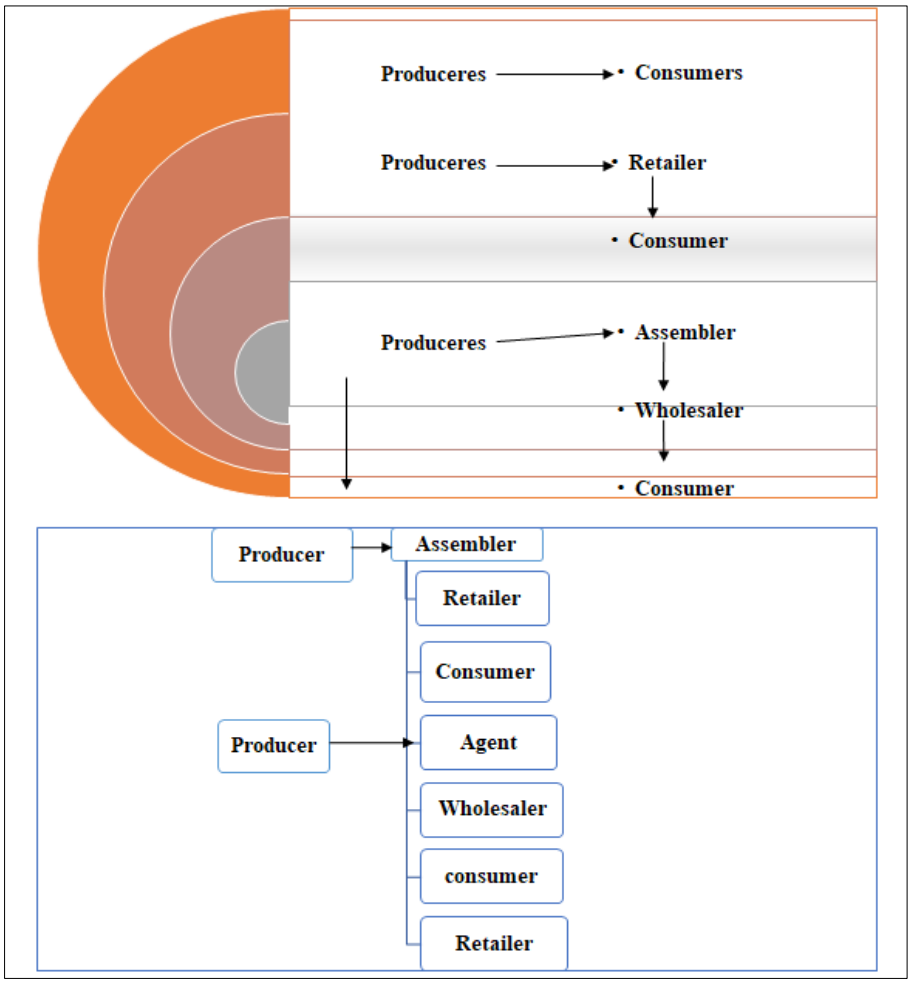

Figure 5: The marketing system of value chain of mung bean (own skech).

Table 2: The effects phosphorus fertilizer rate and row spacing on grain yield of mung bean on 2020 cropping season at Sankura wereda Jejebicho research Station

	2020	**2021**	
Phosphorus rate	**Grain yield (kg ha^{-1})**	**Grain yield (kg ha^{-1})**	**Mean**
0 kg ha^{-1}	1285.50c	1233.53c	1259.52b
20 kg ha^{-1}	1347.04c	1325.89c	1336.46ab
40 kg ha^{-1}	1541.79b	1541.67b	2163.96a
60 kg ha^{-1}	1880.76a	1917.84a	1899.30ab
LSD (p0.05)	118.96	100.7	889.79
Row Spacing			
5cmx40cm	1307.37c	1318.76c	1779.73
10cmx40cm	1744.56a	1715.94a	1730.25
15cmx40cm	1489.39b	1479.51	1484.45
LSD (p0.05)	103.02	87.21	770.58
CV (%)	8.04	6.85	24.67

Where, PR= Phosphorus rate, RS=Row spacing, Source (Wondimkun and Hailu, 2022)

Table 3: Effects of phosphorus fertilizer rate and row spacing on grain yield of mung bean on 2020 and 2021 cropping seasons at Ziway Abine germama kebele

	2020	2021	
Phosphorus rate	**Grain yield (kg ha^{-1})**	**Grain yield (kg ha^{-1})**	**Mean**
0 kg ha^{-1}	1238.79c	592.39c	915.59d
20 kg ha^{-1}	1441.34c	708.54bc	1074.94c
40 kg ha^{-1}	1815.38b	824.03bc	1319.59b
60 kg ha^{-1}	2285.38a	1187.11a	1736.24a
LSD (p0.05)	215.71	125.98	151.03
Row Spacing			
5cmx40cm	1426.98c	625.86c	1026.42c
10cmx40cm	2058.26a	1018.24a	1538.25a
15cmx40cm	1685.99b	839.96b	1220.10b
LSD (p0.05)	186.81	109.1	130.79
CV (%)	13.02	15.56	12.25

Source: Wondimkun and Hailu, 2022

The experimental results of different authors revealed that maximum grain yield was obtained from 60, 65 and 90 kg ha^{-1} phosphorus fertilizer rate. This indicates that phosphorus important for pulse crops like mung for better grain yield production.

SUMMARY AND CONCLUSION

Mung bean is one of Ethiopia's most important pulse crops in the lowlands. It grows in tropical and subtropical regions around the world. Mung bean is widely cultivated for human food consumption; it can be used as green manure and livestock feed. Mung bean in Ethiopia can be grown either as a single crop (mono-cropping), rely cropping or as an intercrop (mixed cropping) with other crops by small scale farmers. Intercropping of cereal crops with grain legumes is a widespread focus for current research in Ethiopia as it increases farm income and reduces pressure on land resources. Crop Rotation System of Mung bean with other crops increases both land and crop productivity particularly and is important for sustainable agriculture. The farmers are producing mung bean during *belg* season and through irrigation around Shewarobit North Shewa Amhara Ethiopia. Dry land areas are experiencing low agricultural yields due to severe water shortages and salinity, leading to food scarcity. Mung bean is gaining attention as a short-season crop that can tolerate dry land conditions, and fix atmospheric nitrogen, decreasing soil nutrient depletion. The productivity of mung bean is low in Ethiopia compared to the production reported in other countries around the globe, which might be attributed to low soil fertility, which is also attributed to the limited use of inorganic fertilizer. The huge constraints of pulse crop value-chain production, aggregation and trading, and demand sinks/export. Productivity is below potential due to low input usage, especially chemical fertilizers inability to increase yields, limited availability of seed, limited familiarity with the variety of existing seed types, and limited usage of modern agronomic practices. The link between the producers and the export markets is weak, due to the large number of ineffective intermediaries operating in the value chain. The fragmentation of intermediaries between the producer and consumer markets creates a lack of transparency in markets. We have to support the farmers with recommended agronomic packages, we have to protect disease and insect pest, improved varieties, recommended fertilizer should be applied for better grain yield production of mung bean.

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