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Comparative analysis of yield, agro-climatic conditions, and economic feasibility of mung bean in Logar, Afghanistan

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A B S T R A C T

Mung bean is an important legume crop with significant nutritional and economic value in semi-arid agricultural systems. This study was conducted to evaluate the yield performance, agro-climatic conditions, production practices, and economic feasibility of mung bean cultivation in Logar, Afghanistan. Primary data were collected from 190 randomly selected farmers using a structured questionnaire, while secondary information was obtained from scientific literature and climatic databases. The data were analyzed using descriptive statistical methods, including frequencies, percentages, means, and comparative analyses. The results indicated that mung bean cultivation in Logar covers approximately 100 ha, with an average yield of 0.53 t ha^{-1} and an estimated total production of 104.9 t. Comparative analysis showed that the productivity of mung bean in Logar is lower than that reported for other major mung bean-producing regions within Afghanistan and several producing countries. Although temperature conditions are generally suitable for mung bean cultivation, water scarcity, limited irrigation facilities, low adoption of improved seed varieties, and inadequate agronomic management practices were identified as major constraints affecting productivity. Economic analysis revealed a positive benefit-cost ratio (B:C) of approximately 1.3, indicating that mung bean cultivation is economically feasible despite relatively low profitability. The study concludes that improving irrigation management, promoting improved seed varieties, and strengthening agronomic practices could enhance mung bean productivity and economic returns in Logar under semi-arid conditions.

Keywords: agricultural productivity, climate variability, economic analysis, irrigation constraints, Logar, sustainable agriculture

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1. INTRODUCTION

Mung bean (*Vigna radiata L.)* is an important legume crop widely cultivated in tropical and subtropical regions of the world, particularly in South and Southeast Asia. It plays a significant role in human nutrition and food security because its seeds contain approximately 20.97–31.32% protein, 42.62–61.22% carbohydrates, 3.59–5.09% crude fiber, 0.80–2.00% fat, and 3.46 – 4.85% ash, along with considerable amounts of vitamins and essential minerals (Hou et al., 2019). Moreover, mung bean enhances the sustainability of agricultural systems through biological nitrogen fixation, which improves soil fertility and reduces dependence on inorganic fertilizers (Nair et al., 2018).

Global mung bean production is estimated at approximately 7.2 million metric tons annually, with more than 90% of total production concentrated in South and East Asia (Silva Volpato et al., 2025). India, China, and Myanmar are among the leading producing countries, where favorable climatic conditions and improved crop management practices contribute to higher productivity and sustainable production systems (Schreinemachers et al., 2019). Due to its short growth duration and relatively low water requirement, mung bean is well adapted to semi-arid environments and is frequently cultivated as a rotational crop following cereals (Nair et al., 2018).

In Afghanistan, mung bean has become an increasingly important crop, particularly in the provinces of Farah, Kandahar, Kunduz, Nangarhar, Baghlan, and Laghman (Noorzai et al., 2017). Previous studies have reported that, under favorable climatic conditions and improved crop management practices, mung bean yield may reach 1.0 – 2.2 t ha^{-1} (Pajhwok, 2024; Rashidi et al., 2025). Despite this potential, productivity remains below international standards in many parts of Afghanistan due to limited adoption of improved technologies, inadequate irrigation facilities, poor-quality seed, and insufficient access to modern agronomic practices.

Logar is characterized by a semi-arid climate with hot summers, cold winters_ where the average annual rainfall of approximately 300 mm, and an elevation of about 1,922 m above sea level (Climate-Data.org, 2024). These conditions generally provide a suitable thermal environment for mung bean cultivation. However, water scarcity, limited irrigation infrastructure, low soil fertility, and the limited use of improved production practices remain major constraints affecting crop productivity in the province.

Legume crops play an important role in improving food security, nutritional quality, and soil fertility in Afghanistan. Among these crops, mung bean is valued for its high protein content, short growth duration, and ability to fix atmospheric nitrogen, making it suitable for sustainable agricultural systems (Hou et al., 2019). Despite its agronomic and nutritional importance, mung bean productivity in Afghanistan remains relatively low due to traditional production practices, limited access to improved technologies, and inadequate irrigation and crop management systems.

Although mung bean cultivation has expanded in recent years in Logar, limited information is available regarding its productivity, agro-climatic suitability, and economic performance under local farming conditions. Furthermore, no comprehensive study has been conducted to compare mung bean production in Logar with other mung bean-producing regions of Afghanistan and major producing countries worldwide. This knowledge gap limits the development of evidence-based recommendations for improving productivity and profitability under semi-arid conditions.

Therefore, the present study was conducted to evaluate the current status of mung bean production in Logar, Afghanistan. Specifically, the study aimed to assess yield performance, analyze agro-climatic conditions, evaluate economic feasibility, and compare the productivity of mung bean in Logar with that reported from other producing regions. The findings of this study provide scientific information that may support future research, agricultural planning, and improved production strategies for mung bean cultivation in semi-arid environments.

It was hypothesized that the average yield of mung bean in Logar is lower than the yields reported for other major mung bean-producing regions of Afghanistan and selected producing countries worldwide.

2. MATERIALS AND METHODS

2.1 STUDY AREA

The study was conducted in Logar, eastern Afghanistan, located at an elevation of approximately 1,922 m above sea level. The province is characterized by a semi-arid climate with hot summers, cold winters, an average annual temperature of approximately 11°C, and annual precipitation of about 300 mm (Climate-Data.org, 2024). These climatic conditions generally provide a suitable environment for mung bean cultivation; however, limited water availability remains a major constraint affecting crop productivity.

2.2 Research Design

The study employed a descriptive survey design combined with a comparative analysis of secondary data. Primary data were collected from mung bean farmers in Logar, while published information from other Afghan provinces and major mung bean-producing countries was used for comparative assessment.

2.3 Sampling Procedure and Sample Size Determination

Primary data were collected using a random sampling technique. The sample size was determined using Cochran's formula (Cochran, 1977), following established principles of sample size determination in survey research (Ahmed, 2024):

$$n = z^2pq/e^2$$

where n is the required sample size, z is the standard normal deviate corresponding to a 95% confidence level (1.96), p is the estimated proportion of the target population (0.7), q is the complementary proportion ($1 - p = 0.3$), and e is the acceptable margin of error (0.06). A total of 190 questionnaires were distributed among mung bean farmers across different districts of Logar and were used for data collection and analysis.

2.4 Data Collection

Primary data were collected through a prepared questionnaire administered to mung bean farmers in Logar. Information was obtained on cultivated area, yield, seed sources, irrigation practices, soil fertility management, and major production constraints affecting mung bean production. Field observations were also conducted to verify and supplement information obtained through farmer interviews. Secondary data were collected from published scientific literature, institutional reports, meteorological databases, and other relevant academic sources. Climatic information was obtained from Climate-Data.org and related databases to support the agro-climatic assessment of the study area.

2.5 Data Analysis

The collected data were coded, organized, and analyzed using Microsoft Excel. Descriptive statistical methods, including frequencies, percentages, means, and comparative tabular analyses, were used to summarize production practices, yield performance, agro-climatic characteristics, and economic indicators of mung bean production in Logar. Comparative assessments were conducted using published data from other Afghan provinces and major mung bean-producing countries. Economic feasibility was evaluated using the Benefit-Cost Ratio (B:C), which was calculated as the ratio of gross income to total production cost. Tables and figures were prepared using Microsoft Excel to facilitate the presentation and interpretation of the results.

3. RESULTS

3.1 Yield Analysis of Mung Bean in Logar

Based on a survey of 190 mung bean farmers, approximately 100 ha of land were cultivated with mung bean in Logar, Afghanistan. The average yield was estimated at 0.53 t ha^{-1}, resulting in a total production of approximately 104.9 t (Table 1). These findings provide an overview of the current status of mung bean production in the study area. As presented in Table 1, mung bean yield varied among districts, ranging from 0.49 to 0.55 t ha^{-1}. Mohammad Agha, Pul-e Alam, and Baraki Barak districts represented approximately 70% of the total cultivated area, suggesting that mung bean production in Logar is concentrated in a few major production districts.

Table 1. Mung bean production indicators by district in Logar

District	Number of Farmers	Cultivated Area per Farmer (ha)	Total Cultivated Area (ha)	Yield (t ha^{-1})	Total Production (t)
Mohammad Agha	52	0.57	29.6	0.526	30.6
Pul-e Alam	45	0.56	25.2	0.52	26.0
Baraki Barak	31	0.49	15.2	0.55	16.5
Khoshi	21	0.48	10.1	0.54	10.8
Charkh	21	0.48	10.1	0.51	10.2
Kharwar	10	0.50	5.0	0.50	5.0
Azra	10	0.50	5.0	0.49	4.9
Total	190	—	100	0.53	104.9

3.2 Comparative Yield Data

Table 2 compares the average yield of mung bean in Logar with yields reported from selected Afghan provinces and major mung bean-producing countries. As shown in Table 2, the average mung bean yield in Logar (0.53 t ha-^{1}) was lower than the yields reported for the selected Afghan provinces and major mung bean-producing countries included in the comparison.

Table 2. Comparison of mung bean yield in Logar, selected Afghan provinces, and major mung bean-producing countries

Region / Country	Yield (t ha^{-1})	Source
Logar (Afghanistan)	0.53	Present study
Farah (Afghanistan)	2.00	Pajhwok (2024)
Kandahar (Afghanistan)	1.50–1.82	Noorzai & Choudhary (2017); Fazil et al. (2024)
Kunduz (Afghanistan)	1.22	Khaleeq (2024)
Kabul (Afghanistan)	1.21	Rashidi et al. (2025)
Baghlan (Afghanistan)	1.24	Singh et al. (2018)
India	1.21	Chaudhary et al. (2023)
Pakistan (Punjab)	0.90	Government of Pakistan (2022)
Myanmar	1.30	Schreinemachers et al. (2019)
China	1.00	Industry Research (2024)

3. 3 Agro-Climatic Analysis

Comparative agro-climatic data presented in Table 3 show differences in elevation, temperature, and annual precipitation among the selected Afghan provinces and mung bean-producing countries. Logar had an average annual temperature of 11 °C and annual precipitation of 306 mm. Farah and Kandahar received lower annual precipitation than Logar, whereas Kunduz and Baghlan showed relatively similar precipitation levels. The selected mung bean-producing countries generally exhibited higher average temperatures and wider ranges of annual precipitation compared with Logar.

Table 3. Comparative agro-climatic characteristics of Logar, selected Afghan provinces, and major mung bean-producing countries

Region / Country	Elevation (m)	Average Annual Temperature (°C)	Annual Precipitation (mm)	Source
Logar (Pul-e Alam)	~1,922	11.0	306	Climate-Data.org (2024)
Farah	~750	20.7	100–150	
Kunduz	~351	16.9	300–400	
Kandahar	~1,010	20.0	~200	
Baghlan	~510	18.5	284	
India	—	20–30	600–1000	Nair et al. (2018)
Pakistan (Punjab)	—	25–35	300–800	Pakistan (2022)
Myanmar	—	25–30	1000–2000	Schreinemachers et al. (2019)
China	—	25–30	500–1000	Industry Research (2024)

3.4 Economic Analysis of Mung Bean Cultivation

The economic analysis indicated that the average cost of mung bean production in Logar was approximately 28,000 AFN ha^{-1}, whereas the average gross income was about 37,000 AFN ha^{-1}. Consequently, the average net income was approximately 9,000 AFN ha^{-1}. The Benefit Cost ratio (B:C) for mung bean production in Logar was 1.3 (Table 4).

Table 4. Comparison of economic indicators of mung bean cultivation in Logar and selected regions

Province	Yield (kg ha^{-1})	Market Price (AFN kg^{-1})	Gross Income (AFN ha^{-1})	Total Cost (AFN ha^{-1})	Net Income (AFN ha^{-1})	B:C	Citation
Logar	500–600	70	37,000	28,000	9,000	1.3	Field estimate
Nangarhar	650–750	65–70	42,000–50,000	28,000–30,000	14,000–20,000	1.4–1.7	MAIL (2021)
Helmand	700–800	65–68	45,000–53,000	28,000–32,000	15,000–22,000	1.5–1.8	Hamim & Choudhary (2019)
Kandahar	800–900	65–70	49,000–63,000	30,000–33,000	19,000–30,000	1.6–1.9	MAIL (2021)
India	900–1,200	75–85	67,500–102,000	38,000–48,000	30,000–54,000	1.8–2.2	Islam et al. (2011)
Bangladesh	1,000–1,400	70–80	70,000–112,000	35,000–46,000	35,000–66,000	2.0–2.4	Islam et al. (2011)

3.5 Comparative Economic Data

Data on the economics of some of the other provinces of Afghanistan and from other countries were obtained through other published sources (Table 4) and analyzed for comparison purposes (MAIL, 2021; Hamim & Choudhary, 2019; Islam et al., 2011). The data presented in Table 4, indicate differences in economic returns across regions.

3. 6. Production Management Practices

The frequency analysis of farm management practices shows that 87.9% of farmers engaged in pest and disease management, compared to 86.8% for weed management; however, only 77.4% followed crop rotation as a management practice and 76.3% adhered to proper timing of planting.

On the contrary, implementation of improved seeds was completed by only 29.5% of farmers and only 25.3% of farmers followed the recommendations for fertilization. The use of appropriate methods for planting was carried out by only 19.5% of farmers. Among the surveyed farmers, 91.1% reported experiencing water scarcity or inadequate irrigation facilities, indicating that water

availability is a major production constraint in the study area. The data in Table 5, summarize the level of adoption of different agronomic practices among farmers.

Table 5. Frequency analysis of production practices affecting mung bean cultivation

No.	Production Factor	Response	Frequency (n)	Percentage (%)
1	Use of improved seed varieties	Yes	56	29.5
		No	134	70.5
2	Standard application of organic and chemical fertilizers for soil fertility	Yes	48	25.3
		No	142	74.7
3	Planting carried out at the appropriate time	Yes	145	76.3
		No	45	23.7
4	Observance of crop rotation	Yes	147	77.4
		No	43	22.6
5	Weed control practices implemented	Yes	165	86.8
		No	25	13.2
6	Pest and disease control conducted	Yes	167	87.9
		No	23	12.1
7	Appropriate planting method used	Yes	37	19.5
		No	153	80.5
8	Farmers possessed adequate skills and experience	Yes	62	32.6
		No	128	67.4
9	Presence of water scarcity or a weak irrigation system	Yes	173	91.1
		No	17	8.9

4. DISCUSSION

The findings of this study indicate that mung bean productivity in Logar was lower than that reported for other mung bean-producing provinces of Afghanistan and several major producing countries (Fig. 1). Similar studies conducted in Farah, Kandahar, Kunduz, Kabul, and Baghlan reported higher yields than those observed in the present study (Baghlani et al., 2024; Khaleeq et al., 2025; Noorzai et al., 2017). Likewise, average mung bean yields reported from India, Myanmar, China, and Pakistan were higher than those recorded in Logar (Mitra & Kumar, 2024; Schreinemachers et al., 2019; Pakistan, 2022). The comparatively low yield observed in Logar may be attributed to several production constraints identified through the questionnaire survey. Water scarcity and weak irrigation systems were reported as the most important limitations affecting production. In addition, low adoption of improved seed varieties, inadequate fertilizer application, and limited implementation of recommended agronomic practices may have contributed to reduced productivity. Similar constraints have been identified as major factors limiting mung bean production in semi-arid environments (Islam et al., 2011; Singh et al., 2021). Consequently, low productivity may reduce farmer income, limit production efficiency, and decrease the contribution of mung bean to household food security.

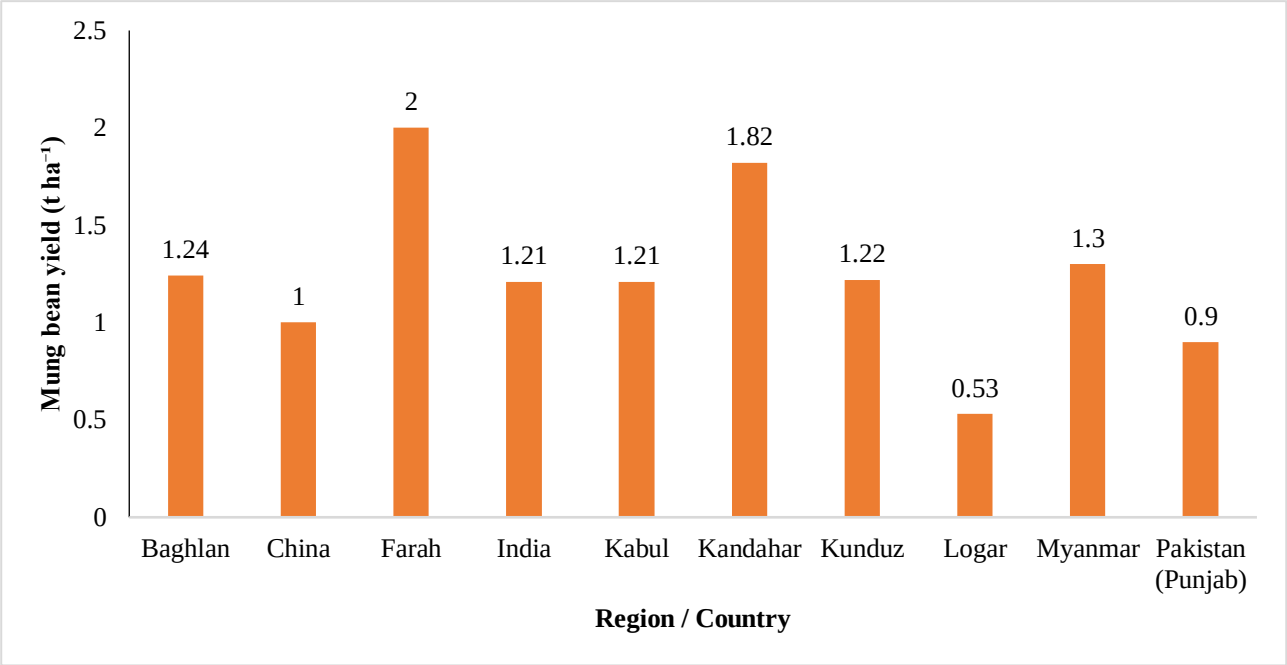


Figure 1. Comparison of average mung bean yield among Logar, selected Afghan provinces, and major mung bean-producing countries (t ha-¹).

The agro-climatic analysis suggests that temperature conditions in Logar are generally suitable for mung bean cultivation. However, annual precipitation is relatively low and occurs mainly during winter and spring, whereas mung bean is cultivated during the summer growing season. Therefore, water availability during flowering and grain-filling stages may be insufficient to support optimum crop growth and yield development. Previous studies have shown that adequate soil moisture during critical growth stages is essential for achieving satisfactory mung bean yields (AVRDC – World Vegetable Center, 2012). The perceptions of farmers obtained through the survey were consistent with the climatic conditions of the region, where water scarcity was identified as the principal environmental constraint. Although provinces such as Farah and Kandahar experience relatively drier conditions, higher yields have been reported where irrigation facilities and water resources are more accessible (Noorzai & Choudhary, 2017). Similarly, major mung bean-producing countries such as India and China achieve higher productivity through favorable moisture availability and improved crop management practices (Schreinemachers et al., 2019).

The economic analysis indicated that mung bean cultivation in Logar remains economically feasible, as reflected by a Benefit Cost ratio (B:C) greater than one. However, relatively low productivity limits overall profitability when compared with other provinces and countries. Previous studies have reported that improved varieties, efficient irrigation management, and better agronomic practices contribute to higher yields and improved economic returns from mung bean cultivation (Islam et al., 2011; MAIL, 2021). Therefore, enhancing irrigation infrastructure, improving access to quality seed, and promoting recommended production practices may increase both productivity and economic benefits for farmers. These findings further suggest that improving production efficiency is essential for strengthening the economic sustainability of mung bean cultivation in Logar.

5. CONCLUSION

This study evaluated the productivity, agro-climatic suitability, production practices, and economic feasibility of mung bean cultivation in Logar, Afghanistan. The results showed that the average mung bean yield was 0.53 t ha^{-1}, which was considerably lower than the yields reported for other major mung bean-producing regions of Afghanistan and selected producing countries. The survey findings indicated that water scarcity and weak irrigation systems were the most important production constraints, reported by 91.1% of farmers. In addition, the adoption of improved seed varieties

(29.5%) and recommended fertilizer practices (25.3%) was relatively low, which may have contributed to reduced productivity. Although the agro-climatic assessment showed that temperature conditions are generally suitable for mung bean cultivation, limited water availability during the growing season remains a major challenge. Economic analysis revealed a positive Benefit-Cost Ratio (B:C) of 1.3, indicating that mung bean cultivation is economically feasible despite relatively low profitability. Based on these findings, improving irrigation infrastructure, increasing access to improved seed varieties, and promoting recommended agronomic practices are essential to enhance productivity and economic returns. Further field-based research is recommended to evaluate improved varieties, irrigation strategies, and nutrient management practices under the agro-climatic conditions of Logar.

Author Contributions

Fazal Hanan Safi conceived and designed the study, conducted data collection, performed data analysis, and prepared the original manuscript draft. Saleman Sultani contributed to the study design, literature review, and manuscript editing. Sediqullah Hammas contributed to data interpretation, economic analysis, and critical revision of the manuscript. Abdullah Zaland assisted with methodology development, validation of the results, and manuscript review. Said Hafizullah Hayat supervised the research, provided academic guidance, and critically reviewed and approved the final version of the manuscript. All authors have read and approved the published version of the manuscript.

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Data Availability Statement

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no conflict of interest.

Artificial Intelligence (AI) Use Statement

Artificial intelligence tools were used only to improve the language and readability of the manuscript. The authors take full responsibility for the scientific content, data analysis, interpretation of results, and conclusions presented in this manuscript

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