Economic evaluation of Mung bean (*Vigna radiata*) intercrop within Malabar neem (*Melia dubia*) based agroforestry system in semi-arid region of Bundelkhand, India

Abstract

Bundelkhand region of India is known in the entire country for moisture scarcity and crop failure due less rainfall and falls in the semi-arid zone. Short-duration crops having the capacity to withstand moisture scarcity are generally grown in this region, apart from Kharif and Rabi season crops. Moong bean (*Vigna radiata*) is one such short-duration crop which mainly grown in this region. Hence, Moong bean intercrop was selected to cultivate within agroforestry systems for resources optimization and mutual benefits. Nevertheless, agroforestry is gaining momentum in the Bundelkhand region due to multiple benefits for ecological and economical aspects. Apart from decreasing the chance of total crop failure, agroforestry provides subsidiary output such as timber and firewood. Among various trees preferred under agroforestry, Malabar neem (*Melia dubia*) is one of the important tree species that is highly valued for its timber that is used in the furniture industry as well as in the pulpwood and plywood industry. Combination of both Moong bean and Malabar neem not only enhances the chance of profitability but also provides an alternative to sole cropping of both the components. Therefore, the present experiment was conducted at Forestry Farm, RLBCAU, Jhansi to investigates the economics of *Vigna radiata* within *Melia dubia* based agroforestry system for its feasibility over sole cropping of both the agro-systems. The result showed that the highest BCR (3.14), gross return (3,78,566 rupees/ha), net return (2,65,940) and land equivalent ratio (2.19) observed in T_5 [*Melia dubia* with spacing 5m×3m + *Vigna radiata*] as compared to other agroecosystems. On the basis of economic feasibility, Moon bean should be grown under Malabar neem with spacing 5m×3m based agroforestry system which is recommended to the farmers of Bundelkhand region for higher profitability.

Keywords: Moong bean, Malabar neem, BCR, LER, agroecosystem, agroforestry, profitability, semi-arid region

Introduction

The Bundelkhand region of central India is mainly characterized by undulating and rugged topography, highly eroded soils with poor soil fertility, scarce groundwater resources and erratic rainfall with poor irrigation facilities leading to frequent droughts and crop failures (Gupta *et al.*, 2009). This region falls in semi-arid, subtropical climate, which receives an average annual rainfall of 867 mm. The maximum part of the rainy season (more than 90%) is received only during 3 months, *i.e.*, July to September (Tewari *et al.*, 2016).

Due to semi-arid climate, crop failure is a major issue in this region and such climatic situation adversely affects the growth and yield of agricultural crops (Dhaka and Prajapati, 2022; Muchomba *et al.*, 2023; Patel and Gangwar, 2023). Hence, instead of sole cropping, agroforestry is gaining importance in this region due to additional benefits. In Bundelkhand numerous trees such as Teak (*Tectona grandis*), Babool (*Acacia nilotica*), Sissoo (*Dalbergia sissoo*), Palash (*Butea monosperma)*, Tendu(*Dyospyros melanoxylon*), Harad (*Terminalia chebula*) and Bahera (*Terminalia bellirica*) etc. are predominant species under different agroforestry system. Nowadays, fast growing tree species are being promoted under agroforestry to sustain food security, livelihood security, environment security vis-a-vis developing a highly productive land use system to reduce the adverse

impact of climate change (Dhaka and Jha, 2017; Dhaka and Jha, 2018). Malabar Neem (*Melia dubia* Cav.) is also an important fast growing agroforestry tree species of India, which is distributed naturally in tropical and sub- tropical regions and introduced in many counties. In industrial agroforestry, Malabar Neem is one of the top ten fast growing tree species recognized by Dhaka *et al.* (2018). Its wood is utilized for making, furniture, pulp, plywood, packing cases, agricultural implements, pencils, splints etc. and as a source of bio-energy (Dhaka *et al.*, 2020; Dhaka *et al.*, 2021). The demand of *Melia dubia* is increasing as an indigenous source for pulp, matchstick, pole and plywood industry in India. Due to wider adaptation ability, *Melia dubia* is suitable for plantation programmes under different agro-climatic conditions. Due to faster growth rate and industrial demand *Melia dubia* provides an alternative to traditional agroforestry tree species (Dhaka *et al.*, 2024).

In agroforestry, although a wide range of species are grown yet leguminous crops are mostly given importance due to the nitrogen fixation ability. Among various leguminous crops, Mung bean is one of the important crops which is traditionally grown in this region to capture the atmospheric nitrogen for plant growth and development. The mung bean (*Vigna radiata* L.) known as green gram, mung, monggo, or munggo is a plant species that belongs to family Fabaceae or Leguminaceae and sub-family Papilionaceae. Mung bean has three subgroups, one of which is cultivated (*Vigna radiata* subsp. radiata) while the remaining two are wild (*Vigna radiata* subsp. lobata and *Vigna radiata* subsp. glabra). Besides being two separate species, it is often confused with black gram (*Vigna mungo*) because of their similar appearances. Due to the mutualistic relationship between rhizobia and the roots of leguminous plant, mung bean enables it to fix atmospheric nitrogen (58-109 kg per ha). It may supply to the soil with a lot of nitrogen (between 30 and 251 kg/ha) which may fulfil their own nitrogen requirement, as well as potential to fix nitrogen for future crops (Jat *et al.*, 2012). Keeping all these factors under consideration, the present research study formulated to evaluates the economic feasibility of Moong Bean (*Vigna radiata*) intercrop within Malabar neem (*Melia dubia*) based agroforestry system in terms of economic parameters such as input cost, gross return, net return, benefit-to-cost ratio (BCR), and Land Equivalent Ratio (LER) for higher profitability.

Methods and Materials

The following study was carried out at RLBCAU, Jhansi. Mung bean was grown under two growing conditions *viz.*, under sole cropping in open field as well as under intercropping in *Melia dubia* based agroforestry system in three different spacings. The growth and yield parameters were assessed at the end of harvest (65 DAS) which is published in the growth and yield paper by the author (Parasriya *et al.*, 2022). At the end of harvest, the economic parameters were assessed as per standard methods. The Mung bean harvested at the end of the study was sold at Market price and different economic parameters were also assessed. Various economic parameters were assessed

using standard formulas as per suggested by Ranawat *et al.*, (2024) and depicted below:

Cost of cultivation: The cost of cultivation was calculated by taking into account the input prices that were in effect when different cultivation practices were used for crop cultivation as well as the establishment and management costs of plantations for various treatments. The cost of cultivation, which includes the cost of various agricultural operations and the labour rate, was computed locally, and the cost of other inputs, such as seeds, fertilizers, fungicides, pesticides, and herbicides, was determined by the actual amount used per hectare.

Gross Return: The total financial returns from the system were computed by summing the total financial returns from the system's intercrop and tree components, taking into a gross return in rupees per hectare using the current local market pricing.

Net Return: Net returns were calculated by deducting total costs from the gross returns. Net return = Gross return – Total Cost of cultivation

Benefit to Cost Ratio: Benefit to Cost Ratio = Gross Return (Rs/ha) / Total cost of Cultivation (Rs/ha)

Land Equivalent Ratio: Land Equivalent Ratio = {Crop A (Tree) yield in mixture/ Crop A (Tree) yield in Monoculture} + {Crop B yield in mixture/ Crop B yield in Monoculture}

Results and Discussions

The result of present study provides an insight into the spacing of tree species in agroforestry in terms of economic parameters over the spacing of crop components. Here, three different planting distance of *Melia dubia* was taken along with Moong bean as an intercrop and the economic assessment was done on the basis of economic parameters. The result showed that the highest BCR (3.14), gross return (3,78,566 rupees/ha), net return (2,65,940) and land equivalent ratio (2.19) observed in T_5 [*Melia dubia* with spacing 5m×3m + *Vigna radiata*] as compared to other agroecosystems (Table 1). However, the lowest BCR (1.86), and LER (1.03) recorded in T_4 [Sole tree cropping of *Melia dubia* with spacing 5m×5m]. This result is consistent with previous research studies conducted by Ranawat *et al.*, (2024) in Okra cultivation (*Abelmoschus esculentus*) under Malabar neem (*Ailanthus excelsa*) based Agro-Silviculture System in a semi-arid region of Haryana, India; Mevada *et al.* (2022) in an agroforestry system based on Teak and Okra; Patil *et al.* (2020) in an agroforestry system based on Teak and Sapota; Dash *et al.* (2024) in a system based on poplar and turmeric. Garima *et al.* (2021) is also reported that agri-silviculture systems yielded higher net returns than sole cropping. Similarly, Yadav *et al.*

(2014) observed greater net returns from growing wheat in Poplar based agroforestry systems. Panwar and Wani (2014) studied wheat cultivation under *Ipomea batata-Populus deltoides* based agroforestry system; Rajalingam *et al.* (2016) studied vegetable cultivation under the *Ailanthus excelsa*-based agroforestry system; and all the authors reported similar results which is in line with the present result.

Table 1: Economic evaluation parameters of different agroecosystems in Bundelkhand Region on India

Sl. No	Treatments	Total cost of Cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BCR	LER
T_1	Sole crop (*Vigna radiata*)	37,284	75,386	42,100	2.02	0.96
T_2	Sole crop (*Melia dubia*-5m×3m)	83,340	2,41,425	1,62,085	2.90	1.28
T_3	Sole crop (*Melia dubia*-5m×4m)	64,300	1,51,250	90,200	2.35	1.16
T_4	Sole crop (*Melia dubia*-5m×5m)	53,160	99,000	48,640	1.86	1.03
T_5	*Melia dubia*-5m×3m + *Vigna radiata*	1,20,624	3,78,566	2,65,940	3.14	2.19
T_6	*Melia dubia*-5m×4m + *Vigna radiata*	1,01,584	2,46,723	1,53,387	2.43	2.10
T_7	*Melia dubia* -5m×5m + *Vigna radiata*	90,444	1,75,359	91,714	1.94	2.00

Conclusion

On the basis of result, the highest BCR (3.14), gross return (3,78,566 rupees/ha), net return (2,65,940) and land equivalent ratio (2.19) was observed in Melia dubia with spacing 5m×3m + Vigna radiata as compared to other agroecosystems. Thus, on the basis of economic feasibility, Moon bean should be grown under Malabar neem with spacing 5m×3m based agroforestry system which is recommended to the farmers of Bundelkhand region for higher profitability.

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Disclaimer (Artificial intelligence)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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