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SOCIO-ECONOMIC DYNAMICS AND CONSTRAINTS OF BLACK PEPPER PRODUCTION IN MEGHALAYA INDIA

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ABSTRACT

Black pepper (*Piper nigrum* L.) holds major economic significance globally and is increasingly emerging as an important spice crop in Meghalaya, India. This study analyzes the economic dynamics, production trends and constraints associated with black pepper cultivation in West Garo Hills district. Primary data were collected from 120 farmers selected through a multistage purposive-cum-random sampling method during 2022 to 2024. Cost concepts (Cost A_1 to Cost C_3), income measures and Henry Garrett's Ranking Technique were employed to assess cost-return structure and production constraints. Trend analysis based on secondary data (2004-2005 to 2020-2021) revealed that while the area under cultivation remained relatively stable, productivity consistently improved, reaching 0.66 MT / ha by 2020-2021. Compound Growth Rate (CGR) analysis showed positive growth in production during early years, followed by stagnation in recent periods. Socio-demographic profiles indicated dominance of middle-aged male farmers actively engaged in cultivation. Major constraints identified were pest and disease incidence, high transportation costs, unpredictable weather conditions, limited technical knowledge of government schemes and inadequate storage facilities. The findings emphasize the need for improved extension services, climate-resilient practices, pest management and infrastructural support to strengthen the sustainability and profitability of black pepper cultivation in Meghalaya.
Keywords **:** Black pepper, *Piper nigrum*, Cost of cultivation, Garrett ranking, Meghalaya, Productivity.

Introduction

Black pepper (*Piper nigrum L.*), widely recognized as the "King of Spices," is one of the oldest and most valuable spices in the world. Belonging to the family Piperaceae, it holds immense importance in culinary, medicinal and economic sectors (Ranjeetha, 2018). Often referred to as "Black Gold" due to its high commercial value and demand in international markets, black pepper has remained integral to human civilization for centuries. Its uses extend from enhancing the flavor of food to serving as a source of pharmacologically active compounds possessing antioxidant, anti-inflammatory and antimicrobial properties. India continues to play a dominant role in global spice trade as one of the leading producers and exporters of black pepper (Singh *et al*, 2009). Indian pepper is highly valued for its distinctive aroma, flavor and medicinal qualities, contributing significantly to the nation's export earnings (Chakravorthy and Banu, 2017). Globally, the black pepper market has shown consistent growth and is projected to reach USD 2.60 billion by 2025 and USD 4.33 billion by 2035, reflecting a compound annual growth rate (CAGR) of 5.20 per cent over the period. Vietnam presently leads in production due to favorable climatic conditions and advanced cultivation practices, while India ranks among the top producers after Vietnam and China and stands within the top five exporters alongside Vietnam, Indonesia, Brazil and Malaysia (Ranjeetha, 2008). This growth is further supported by increasing consumer preference for natural food flavors, awareness of health benefits and the rise of organized and online retail sectors. Sustainable and organic cultivation practices, improved supply chains and modern farming technologies are expected to enhance productivity and

ensure long-term market stability (Singh and Sharma, 2020a).

In India, the North Eastern Region (NER) has emerged as a potential hub for black pepper cultivation (Singh and Sharma, 2021a). Initially, the region contributed only about 1.00 per cent to national production; however, it now accounts for approximately 10.00 per cent, reflecting remarkable growth and farmer adoption (Verma *et al*., 2022). The region's diverse agro-climatic conditions, well-distributed rainfall and fertile virgin soils make it highly suitable for black pepper cultivation. Meghalaya, in particular, has shown steady progress, with data from the Department of Agriculture indicating fluctuations in area but improvement in productivity. In 2004-2005, the state recorded 338 ha under black pepper with a production of 154 metric tonnes, while by 2020-2021, the area stood at 311 ha with a production of 204 metric tonnes (Singh and Sharma, 2021b). This indicates a notable increase in productivity despite a slight reduction in area (Das and Singh (2011) highlighted that the subtropical humid climate of the West Garo Hills district is ideal for horticultural crops, providing a favorable environment for year-round cultivation of black pepper. Tribal Garo farmers have also demonstrated innovative practices, such as using decomposed or decayed tree logs to enhance pepper yields an example of indigenous knowledge integrated with sustainable farming.

Globally, Vietnam leads black pepper production with 36.50 per cent of total output, followed by Brazil (12.70 per cent), Indonesia (12.20 per cent), India (9.00 per cent) and China (4.60 per cent) (World Population Review, 2023). Within India, Kerala, Karnataka and Tamil Nadu remain the major pepper-growing states, while Meghalaya's contribution is steadily rising with the highest yield per hectare (Spices Board India, 2023). Economically, black pepper plays a vital role as a major spice in culinary applications and as an essential ingredient in processed foods, traditional medicines and pharmaceuticals. Its active compound, piperine, enhances nutrient bioavailability and exhibits analgesic, antipyretic, antioxidant and antimicrobial properties (Babu *et al*., 2019). It is also used in Ayurveda for treating malaria, gastrointestinal and respiratory ailments and serves as a natural insecticide. In the food industry, it is widely utilized in meat processing, pickling, baking and beverage preparation due to its strong flavor and preservative attributes (Srinika *et al*., 2017). Given this significance, the present study was undertaken to examine the trends in area, production and productivity of black pepper in Meghalaya over the period 2004-2021 (GoI, 2024), to assess the cost of cultivation and analyze the economic viability of black pepper production in West Garo Hills district, to evaluate the income measures and profitability indicators of black pepper growers, and to identify and rank the major constraints faced by farmers in the production of black pepper using Garrett's Ranking Technique (Chishi and Sharma, 2019).

Materials and Methods

The present study was conducted in the west Garo hills district of Meghalaya, which is one of the major black pepper growing areas in the state. The district is situated between of 600 to 800 meters above mean sea level. It has a humid subtropical climate characterized by high rainfall ranging from 2500 to 3000 millimeters annually, moderate temperatures varying between 18 ^{0}C to 32 ^{0}C and red loamy soils rich in organic matter, all of which are ideal for black pepper as a major cash crop.

A multi stage purposive cum random sampling techniques was employed to select the respondent for the study. In the first stage, two blocks Demdema and Tikrikilla were purposively chouse from the seven blocks West Garo Hills based on their extensive black pepper cultivation. In the second stage, six villages (three form each block) were selected, taking into account the concentration of black pepper growers and their accessibility. In the third stage, twenty farmers were randomly selected from each village using farmer list obtained from the local agricultural development offices, giving a total sample size of 120 respondents. Primary data used for the study was collected from the selected from the selected black pepper cultivators using the personal interview method with help of a pre-structured interview schedule. The primary data with respect to inputs used (Human labour, seed, fertilizer, irrigation charge, plant protection measures, etc.) and output of black pepper in both physical and monetary terms and information regarding problems in the production of black pepper were collected for 2022-2024.

To analyze the constraints faced by the producers in the production of black pepper. Henry Garrett's technique was used. The respondents were asked to rank the constraints, which were converted into scores.

$$\textbf{Per cent position} = \frac{100(Rij-0.5)}{Nj}$$

Whereas: Rij = Rank for jth factor by jth respondent,

Nj = Number of factors ranked by jth respondent

Results and Discussion

The socio-demographic profile of black pepper growers in West Garo Hills revealed considerable variation in age, gender, marital status, education and family size. A large proportion of farmers belonged to the middle-aged group (44.17 per cent), followed by young growers (37.50 per cent), while per cent only 18.33 per cent were older than 57 years. Male farmers represented the majority at 76.67 per cent, whereas women accounted for only 23.33 per cent, indicating predominantly male involvement in black pepper cultivation. Most respondents were married (65.00 per cent), suggesting access to family labour and greater household stability in farming decisions. Educational levels varied widely: 6.67 per cent were illiterate, 5.83 per cent functionally literate, 14.17 per cent had primary education, and the largest share (25.83 per cent) had studied up to middle school. About 20.00 per cent had completed high school, 17.50 per cent higher secondary, and 10.00 per cent were graduates or above. Family size analysis showed that 54.17 per cent belonged to small families of up to four members, 27.50 per cent to medium families, and 18.33 per cent to large families, influencing labour availability and household consumption patterns. Similar studies was reported by Yani and Sharma (2022).

The economic characteristics of the respondents indicated that landownership was predominantly small and marginal. About 45.00 per cent of growers owned small farms (1.01 to 4.00 ha), followed by 29.17 per cent marginal farmers with less than one hectare, while 25.83 per cent had medium-sized holdings (4.01–10 ha). No farmers possessed more than 10 hectares, confirming the smallholder nature of black pepper farming in the region. Income levels were similarly varied: 35.00 per cent of farmers belonged to the low-income group (up to Rs. 1.16 lakh), 37.50 per cent were in the medium-income category (Rs. 1.161 to 2.26 lakh), and 27.50 per cent earned above Rs. 2.26 lakh annually. This distribution shows that while black pepper contributes significantly to household income, many growers still operate within modest income levels due to limited land size, variable yield performance, and other production-related challenges. However, the presence of over one-fourth of farmers in the high-income category highlights the potential of black pepper as a profitable crop when supported by improved cultivation practices and better access to essential resources.

Compound Growth Rate (CGR) of Area, Production and Productivity of Black Pepper in Meghalaya

The analysis of trends in the area, production and productivity of black pepper in Meghalaya from 2004-2005 to 2020-2021 reveals a gradual yet consistent improvement in the crop's performance over time.

Table 2 reveals the secondary data that the initial year recorded 338 ha under cultivation, 154 MT of production and a productivity level of 0.46 MT / ha. Although a slight decline occurred during 2008-2009 and 2009-2010, with the area falling to 336 ha and productivity dropping to 0.44 MT / ha, the sector began to recover from 2011-2012 onward. A significant improvement was observed in 2012-2013 when the area increased to 355 ha and production rose to 214 MT, elevating productivity to 0.60 MT / ha. Subsequent years showed steady advancement and by 2014–2015 productivity reached 0.63 MT / ha. The positive trajectory continued through 2016–2017 and beyond, culminating in 2020-2021 with 311 ha of area, 204 MT of production and the highest recorded productivity of 0.66 MT / ha. These findings indicate that while the area under cultivation remained relatively stable, productivity and production followed a sustained upward trend, reflecting gradual improvements in management practices and crop performance over the study period. Similar studies was reported by Yadav *et al*., (2022).

Table 3 reveals the compound growth rate (CGR) analysis further supplements these findings by explaining shifts in growth patterns across different time periods. Period I (2004-2013) witnessed a marginal increase in area (0.96 per cent) with low consistency, whereas production grew considerably by 6.50 per cent, supported by a high R^2 value, highlighting meaningful gains driven largely by enhanced productivity rather than area expansion. In Period II (2014-2020), both area (-0.00135 per cent) and production (-0.36 per cent) recorded slight declines, accompanied by very low R^2 values indicating unstable or unreliable trends, signaling stagnation possibly due to climatic, management, or socio-economic constraints. Over the entire period (2004-2020), area experienced a slow decline (-0.98 per cent) while production remained nearly constant (0.0 per cent CGR) but relatively stable, as reflected by an R^2 of 0.66. Overall, the CGR analysis demonstrates that Meghalaya's black pepper sector achieved early improvements in productivity, followed by stagnation in later years, emphasizing the need for technological advancements, improved cultivation practices, and supportive government interventions to enhance long-

term production growth. Similar studies was reported by Singh and Sharma (2020b).

Constraints Faced in the Production of Black Pepper

Table 4 reveals the major production constraints encountered by black pepper growers were identified and ranked using Garrett's Ranking Technique. The results indicate that the incidence of pests and diseases emerged as the most critical constraint (score 105), significantly affecting crop health and yield. This was followed by high transportation costs (97), which increased the overall cost of cultivation, particularly in remote and hilly areas. Unpredictable weather conditions (71), including irregular rainfall and extreme climatic variations, further posed challenges to maintaining stable production levels. Additionally, growers reported inadequate technical knowledge regarding government schemes and subsidies (52), limiting their ability to access improved cultivation practices and financial assistance. The lack of storage facilities (33) was also identified as a constraint, leading to potential post-harvest losses and affecting the quality of produce. These constraints collectively highlight the need for strengthened extension services, improved access to inputs and infrastructure development to enhance black pepper production efficiency.

Conclusions

The study highlights that black pepper cultivation in West Garo Hills, Meghalaya, demonstrates strong potential due to favorable agro-climatic conditions and increasing interest among farmers, particularly younger and middle-aged groups. Despite fluctuations in cultivated area, productivity has shown a steady upward trend over the past two decades, reflecting gradual improvements in management practices and crop performance. However, production growth has stagnated in recent years, indicating the need for targeted interventions. Economic analysis shows that black pepper remains a viable cash crop, but farmers face critical challenges such as pest and disease outbreaks, high transport expenses, erratic weather, limited awareness of government support programmes, and inadequate storage facilities. Addressing these constraints through integrated pest management, better transport and storage infrastructure, farmer training and enhanced extension services will significantly improve production efficiency and profitability. Strengthening institutional support and promoting modern, sustainable practices are essential for harnessing the full economic potential of black pepper cultivation in Meghalaya.

Recommendations

Some policies can be drawn for further improvement related to farming and adoption viz;

- Systemic production through black pepper is remunerative and promising.
- Value addition and processing of enterprises for additional income generation.
- By supply of quality input supply, market intelligence with risk management knowledge should disseminate.
- Empowering farmers with ICT tools like farm kiosk for real time access to information.
- The interest rate of bank loans should be lowered for credit facilities.
- Introduction of Weather Based Crop Insurance Scheme on a wider scale to income security.

Declarations

Ethical consideration

Ethical issues (including plagiarism, consent to publish, misconduct, data fabrication and / or falsification, double publication and / or submission, and redundancy) have been checked by all the authors.

Competing interests

The authors declare that there are no competing interests. This research did not receive any specific grant from a funding agency in the public, commercial or not for profit sectors.

Table 1 : Trends in Area, Production and Productivity of Black Pepper in Meghalaya

S.N.	Year	Area (ha)	Production (MT)	Productivity (MT/ha)
1.	2004–2005	338.00	154.00	0.46
2.	2008–2009	336.00	151.00	0.45
3.	2009–2010	336.00	148.00	0.44
4.	2010–2011	337.00	150.00	0.45
5.	2011–2012	341.00	159.00	0.47
6.	2012–2013	355.00	214.00	0.60
7.	2013–2014	303.00	186.00	0.61

8.	2014–2015	304.00	192.00	0.63
9.	2015–2016	305.00	196.00	0.64
10.	2016–2017	306.00	199.00	0.65
11.	2017–2018	308.00	201.00	0.66
12.	2018–2019	309.00	202.00	0.66
13.	2019–2020	310.00	203.00	0.65
14.	2020–2021	311.00	204.00	0.66
Total		**4499.00**	**2559.00**	**0.57**

Source: Directorate of Economics and Statistics, Meghalaya

Table 2 : Compound Growth Rate (CGR) of Area and Production of Black Pepper in Meghalaya

S.N.	Period	CGR of Area (%)	R^2 (Area)	CGR of Production (%)	R^2 (Production)
1.	Period–I (2004–2013)	0.96	0.11	6.50	0.62
2.	Period–II (2014–2020)	–0.00136	9.02*	–0.36	0.098
3.	Period–III / Overall (2004–2020)	–0.98	0.49	0.00	0.66

*(The R^2 value 9.02 appears to be a data entry error in the provided data set)

Table 3 : Production Constraints Faced by Black Pepper Growers

S.N.	Production Constraint	Garrett's Score	Rank
1.	Incidence of pests and diseases	105	I
2.	High transportation cost	97	II
3.	Unpredictable weather	71	III
4.	Lack of technical knowledge of government schemes and subsidies	52	IV
5.	Lack of storage facilities	33	V

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