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ABOUT THE JOURNAL

The ASSAM ECONOMIC JOURNAL is a Peer-reviewed journal published annually by the Department of Economics, Dibrugarh University. The objective of the journal is to publish original high-quality research paperswhile providing an academic platform to scholars for deliberation and analysis of various economic issues, with a focus on North East India in particular. However, issues cutting across the regional border, and having relevance and significance on the national and international front are also welcome.

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* From the Editor's Desk

The Assam Economic Journal is the annual blind peer reviewed journal of the Department of Economics, Dibrugarh University. The objective of the journal is to serve as a forum for scholars to analyze and discuss various economic issues, with a particular focus on the economy of the Northeast India.On rigorous review and subsequent modifications, 7 papers have been accepted for publication in the current volume.

The first paper, contributed by Nisha Dahiya and Manish Sharma is about emerging situation of organic farming in Madhya Pradesh. In this paper, the authors critically examine the challenges faced by the farmers practicing organic cultivation.

The next paper contributed by Dikshita Kakoti is about modelling foreign direct investment (inward and outward) and gross fixed capital formation in India. In this paper, Ms Kakoti explores the possible connection between gross fixed capital formation and foreign direct investment (both inflows and outflows) in India during the period 1990 to 2022.

The third paper is on the topic economic analysis of Agarwood cultivation in Assam: an empirical investigation. This paper is contributed by Anshumi Dutta and Pranjal Protim Buragohain. In this paper, the authors have highlighted the economic significance of Agarwood cultivation in Assam and found that the cultivation of the same is highly beneficial.

An interesting work was done by Arnob Paul and Nayanmani B. Baruah on the topic Reassessing the validity of environmental Kuznets curve hypothesis for selected African countries and they found that EKC type of relationship is not observed for the countries of Africa.

Occupational diversification is always a need for the improvement of overall wellbeing of the people, especially for the marginalised communities like the tea garden labour community. Subhashish Gogoi and Nissar A. Barua have examined the status of occupational diversification among the tea garden labour community and found that such diversification highest among the casual workers and lowest among the permanent workers.

The next paper is on determinants of malnutrition among the children in Assam. This paper is contributed by Mahendra Hazarika and Amarjyoti Mahanta and they found that there is the prevalence of malnutrition among the children under the study.

The last paper is about the factors affecting technical efficiency of betelnut producers in Assam. This paper is contributed by Durlov Borah, Pranjal Protim Buragohain and Jitu Saikia. In this paper, they have found that the betelnut cultivation is profitable and there is also the scope to improve technical efficiency.

I, on behalf of the Editorial Board of the Assam Economic Journal, thank the contributors for submitting the papers for publication in the journal. I also regret that few papers could not be published after the review process. The editorial board also expresses sincere gratitude to all the revered reviewers for spending their valuable time in reviewing the papers.

Lastly, I request feedbacks from the scholars; academicians and experts on the concerned field on the quality of papers published in the Journal which can be sent to the editor at the email i.d., ***editoraej@gmail.com***.

- P.P. Buragohain

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EMERGING SITUATION OF ORGANIC FARMING IN MADHYA PRADESH: A TREND STUDY

Nisha Dahiya[*]
Manish Sharma[**]

Abstract:

Madhya Pradesh, boasting an extensive land area benefits from diverse seasons and soil conditions, rendering it conducive to a wide array of agricultural products. According to the NABARD report 2021, agriculture continues to hold its primacy within the Madhya Pradesh economy, offering employment to approximately 57.9 percent of the workforce during the 2020-21 period. Notably, FiBL Survey 2021, Madhya Pradesh leads with 0.76 million Ha which is over 27 per cent of all Indian states in the extent of land dedicated to organic farming, cultivating a diverse range of food crops, including cereals, pulses, and oilseeds. To ensure the safety, purity, enhanced nutrition, environmental friendliness, disease resistance, and overall healthiness of these crops, farmers have enthusiastically adopted chemical-free techniques.

Given the paramount importance of this endeavour, it is imperative to reassess the emerging challenges faced by farmers who have embraced organic farming practices in Madhya Pradesh. This article specifically highlights trends, farmer adoption rates, and the status of irrigation facilities, marketing challenges, and export issues concerning their organic produce. It is crucial to examine the facilities provided by the government of Madhya Pradesh to overcome these challenges and support the organic farming sector.

Keyword: Organic Farming. Conventional Farming. Marketing. Exports. Adoption.

JEL Codes: Q10, Q15, Q18

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Introduction:

Agriculture is one of the most ancient human undertakings, wielding profound influence over the tapestry of human society. The state of Madhya Pradesh within the Indian subcontinent emerges as a potent contributor to the swiftly expanding Indian economy. Central to this economic growth, agriculture manifests as the predominant wellspring of income, notably in the rural regions where an estimated 54.6 percent of the populace resides as per the 2011 Census. It is in these far-off areas that farming not only helps people make a living but also adds value to the money earned from exports to other countries. This is really important for many different types of businesses that rely on materials from agriculture sector.

Farming has changed a lot during the last 50 years. It is so different now that if we compare it to how it used to be, it is like looking at something completely new. But while things have gotten better, there are worries about how it affects our health and the environment. Because of these worries, the state of Madhya Pradesh decided to make strict rules. Madhya Pradesh, with a vast land area of 2.32 lakh hectares (which is a lot!), where they only do organic farming. This is part of an even bigger area of 7.23 lakh hectares all over India (Times, 2015).

The organic farming movement was launched in the early 2000s, finding its genesis in the year 2001-02 an initiative was launched by the National Programme for Organic Production (NPOP), established the groundwork for the country's systematic development of the organic agriculture sector (APEDA, 2018). The APEDA under the Ministry of Commerce and Industry in India is in charge of managing and running NPOP. These enclaves of eco-friendly agriculture were named "organic villages," setting the stage for the gradual spread of this organic farming endeavour. This noble pursuit witnessed an escalation, extending its reach to encompass 3130 villages within the state by 2006-07, a testament to the earnestness with which this endeavour was embraced (PKVY report).

This organic farming crusade, known as the *Paramparagat Krishi Vikas Yojana* (PKVY), received an allocation of Rs. 300 crores in the fiscal year 2015-16. Its overarching objective spanning three years sought to establish 10,000 clusters, encompassing a sprawling expanse of 5 lakh acres devoted to organic agriculture (Ghosh, 2023). This monumental effort does not forsake traditional resources; instead, it harnesses their potential to fortify organic farming. The linkage to the market amplifies its impact, integrating farmers into this transformative movement, elevating domestic production and fostering organic certification.

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The bedrock principles of organic farming incorporate diverse techniques, such as crop rotations, utilization of crop residues, synergizing with legumes, application of green manures, efficient management of off-farm organic waste, judicious utilization of mineral-bearing rocks, and the adept orchestration of biological pest management. These techniques converge to sustain soil productivity, enrich plant nutrients, and exert control over the menace of insects and weeds.

The organic farming landscape in Madhya Pradesh is underpinned by a drive to assess the adoption levels of farmers regarding these organic farming practices. The state government has taken a proactive stance in advocating these techniques, particularly focusing on the main crops and observing with keen interest how farmers embrace the recommended organic farming methodologies. This confluence of agricultural organization and progressive methods reflects the resilience of the farming community in adapting to more sustainable, health-conscious, and environmentally sensitive approaches.

Review of literature:

In recent times, due to the rising demand for organic products, the government of India has introduced various policies to promote organic farming, covering aspects such as initiation, execution, and promotion of organic food items. With the growing interest in organic products both domestically and internationally, there exists significant potential for the expansion of the organic food industry, which generates revenue for strengthening the Indian economy.

Das and others have compiled a series of review articles analyzing the current state of organic farming research and its future growth potential. They find that both the demand for organic food and the production of organic goods are steadily increasing. This peer-reviewed article aims to comprehensively address legal, economic, scientific, and environmental aspects of plant-based organic farming. It explores existing national and international policies related to organic farming and highlights the potential to address global hunger through organic farming (Das, Chatterjee, & Pal, 2020; & Roychowdhury, Gawwad, Banerjee, Bishnu, & Tah, 2013).

The authors discuss the challenges and opportunities for the expansion of plant-based organic farming, emphasizing the crucial relationship between biodiversity and organic agriculture. They delve into the application of innovative OMICS technologies in the context of organic agriculture. Notably, the authors place significant emphasis on factors essential

for growth, such as product certification, customer attitudes, and more. The authors' findings reveal that consumer attitudes towards organic farming vary across different age groups, with younger consumers exhibiting a more favourable outlook on purchasing organic products. However, some potential buyers may be deterred by the higher cost of certified organic goods compared to conventional production techniques. Thus, strategic planning is deemed crucial, requiring a more focused and imaginative approach to overcome these challenges.

In a study conducted by Motiwale, Sharma, and Gurjar in 2020, they looked at how many farmers in the Indore District of Madhya Pradesh were using organic farming methods. They randomly picked two areas in the district for the study. They got a list of villages that practiced organic farming from the State Department of Agriculture. From each selected area, they randomly chose 15 villages for the study. In these villages, they picked 6 farmers from each one using a simple random method, in total 90 farmers were for the final study. They used different statistical tests like frequency, percentage, mean, standard deviation, and correlation coefficient or chi-square test to understand the data. The study showed that only 60% of farmers were using organic farming practices overall. Specifically, 29 respondents had a low level of adoption, 50 had a medium level, and only 11 had a high level. This means that most farmers had a medium level (Motiwale, Sharma, & Gurjar, 2020).

A study conducted by Badodiya, Jain, Maratha, and Gour in 2021, they examined the effectiveness of training programs for tribal farmers in the Barwani district of Madhya Pradesh, specifically focusing on organic farming practices in the west Nimar region. The research revealed that the primary hurdles faced by farmers were the high expenses associated with inputs and the complex preparation methods (Badodiya, Jain, Maratha, & Gour, 2021).

Singh and Sisodia present the current state of agricultural economics in Madhya Pradesh (M.P.), which has transitioned from being part of the BIMARU states to becoming a leading agricultural state due to rapid growth in this sector (Singh & Sisodia, 2022). This transformation is attributed to well-designed agricultural expansion plans. Several significant concerns are highlighted in the paper, requiring careful planning to align with government targets. A key focus is the urgent necessity for the development of new crop species and technologies to ensure sustainable growth without disrupting the ecosystem. Natural farming is emphasized as a means to maintain environmentally sound agricultural practices.

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The paper discusses the investments made by both M.P. and India in agricultural growth, underscoring their importance. Various methods for agricultural extension in M.P. are explored, including the establishment of the ICAR nodal institute, State Agriculture Universities, Krishi Vigyan Kendras, and Agricultural Technology Management Agencies (ATMA). These efforts have resulted in the recruitment and training of adequate personnel to facilitate extension services in the M.P. farm sector. Research and development (R&D) also receive significant attention in the context of expansion, further underscoring its importance in the overall agricultural development of the region.

The comprehensive study by Kaushal and Aggarwal outlines the significant market influences on India's organic farming industry, focusing on permaculture—a practice that establishes and maintains agriculturally productive ecosystems mirroring natural diversity, stability, and resilience on a global scale (Kaushal& Aggarwal, 2022). While organic farming has historical roots, it stands as the sole alternative choice preserving the agro-ecosystem in both socially and environmentally sustainable ways. The paper sheds light on the evolving pattern of land ownership in India, with Madhya Pradesh experiencing a decline in land holdings over the past four decades. It delves into the organic goods market and consumer attitudes towards organic food consumption or purchase. Acting as a conduit, the authors analyze various aspects, including production, marketing, processing, and the environmental impact of organic products.

The overall summary of the empirical literature emphasizing that the findings underscore the crucial role of consumer perception, understanding, and cost acceptability in organic product marketing and adoption of organic farming. Notably, the absence of organic product branding and certification presents significant marketing challenges. However, producers are increasingly pursuing branding and certification to enhance sales and profitability, aiming to in still consumer confidence and reliance. This study offers valuable insights that can inform and guide various stakeholders involved in organic farming, including researchers, policy makers, organic farmers, and consumers, both directly and indirectly involved in it. Under the above backdrop, the present study aims to study the share of organic farming production trends and its contribution to organic product exports in Madhya Pradesh. It also attempts to assess the irrigation facilities and address marketing challenges associated with organic farming in Madhya Pradesh. Further attempt is also

made to determine the adoption rate of organic farming practices among farmers in Madhya Pradesh.

Research Method:

We have opted for data acquisition through systematic sources, including libraries, archives, relevant websites, and official organizational reports.

Data Collection

The research focuses on the evolving landscape of organic farming in Madhya Pradesh (M.P.). The data collection primarily relies on secondary sources, encompassing comprehensive reviews of published works, academic papers, scholarly articles, and newspaper publications. Furthermore, a specific emphasis has been placed on gathering information from the governmental website APEDA, particularly data of past five years, with a special focus on the state of Madhya Pradesh. This secondary data insight into the proportion of organic farming production, the contribution of M.P. to organic farming exports, the status of irrigation facilities within the study area, the challenges encountered in marketing organic products, the rate of adoption of organic farming practices in the study area, as well as general information available within the existing literature.

Data Analysis:

Trends of Share of Organic Farm Production in Madhya Pradesh

In the fiscal year 2020-21, India achieved a noteworthy production of approximately 3,496,800.34 metric tons (MT) of certified organic products (Department of Agriculture & Farmers welfare, 2021). This diverse range of offerings encompasses essential food commodities such as oilseeds, sugar cane, cereals and millets, cotton, pulses, aromatic and medicinal plants, tea, coffee, fruits, spices, dry fruits, vegetables, and processed foods, among others. Notably, the scope extends beyond consumables to encompass the production of organic cotton fiber and functional food products. Within this impressive landscape, Madhya Pradesh stands as the leading contributor among Indian states, with significant production, followed by the states of Maharashtra, Karnataka, Rajasthan, and Uttar Pradesh, which also significantly contribute to the nation's organic production.

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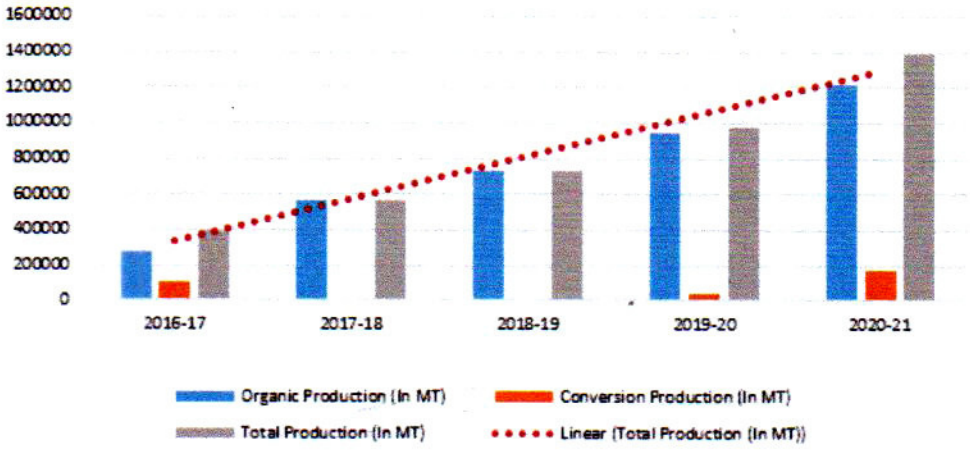
Table-1: Madhya Pradesh Organic Farm Production during 2016-17 to 2020-21

Sl. No.	Year	Organic Production (In MT)	Conversion Production (In MT)	Total Production (In MT)	Increment in total production over Year (In %)
1.	2016-17	283360.00	103238.42	386598.42	-
2.	2017-18	572566.43	2779.86	575346.29	48.82
3.	2018-19	738877.74	7.95	738,885.70	28.42
4.	2019-20	9,45,506.03	35,099.65	9,80,605.68	32.71
5.	2020-21	1214919.50	177176.43	1392095.93	41.96

Source: Data provided by the accredited Certification Bodies under NPOP

Figure 1

Madhya Pradesh Organic Farming prodiction during 2016-17 to 2020-21



Illustrated in Table 1, organic produce production is undergoing rapid expansion. The graphical representation distinctly illustrates the consistent upward trajectory of Madhya Pradesh's (M.P.) share in organic production over the period spanning from 2016 to 2021. Furthermore, the conversion rate exhibits a noteworthy increase, with a rise of 1.61 percent from the fiscal year 2018-19 to 2019-20, followed by a more substantial increment of 3.29 percent from the fiscal year 2019-20 to 2020-21. Both of these trends unmistakably indicate a prevailing upward pattern in the organic production share, signifying a progressive shift in this domain.

Contribution of Madhya Pradesh in Exports of Organic Products

Madhya Pradesh, located in the heart of India, plays a vital role in the country's organic farming sector. Its rich agricultural heritage, coupled with favourable climatic conditions, has made it a significant contributor to the organic produce market. Through the dedicated efforts of farmers and support from governmental initiatives, Madhya Pradesh has established itself as a key player in the cultivation of organic crops. This has not only boosted the state's agricultural economy but has also had a positive impact on India's export of organic products. This will explore the noteworthy contribution of Madhya Pradesh to the global organic market, highlighting the factors driving this success and the positive effects on both the state's economy and the wider organic farming community in India. The contribution of Madhya Pradesh's organic production in the overall exports between the years 2017 and 2021 is given below.

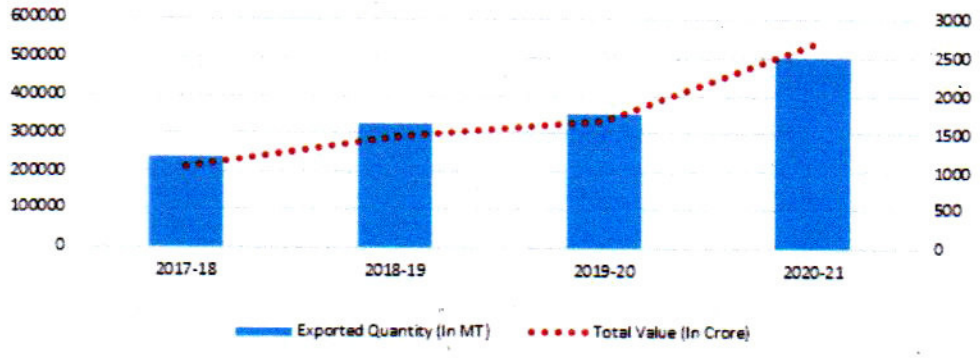
Table 2: Exports from M.P. during year 2017-18 to 2020-21

Years	Exported Quantity (In MT)	Total Value (In Crore)	Total value Increment (In %)
2017-18	237632.68	1051.92	-
2018-19	326511.74	1455.53	38.36
2019-20	351814.26	1670.20	14.748
2020-21	500636.68	2683.58	60.67

Source : APEDA, consolidated organic agricultural statistics

Figure 2

Exports from M.P. during year 2017-18 to 2020-21



in year 2020-21 it was a record high of 60.67% from last year. By referencing Table-2 and Figure-2, it becomes evident that there exists a direct correlation between the expansion of export production and the subsequent escalation in the total value of organic export commodities.

Irrigation Facilities

Madhya Pradesh, the second-largest state in the country, grapples with a significant inadequacy in irrigation water supply. The essential role of water in both agricultural production and human sustenance is undeniable. This scarcity is primarily attributed to the challenging topography, characterized by undulating terrain and high surface runoff, compounded by a lack of suitable surface storage facilities. Remarkably, the state's net irrigated area, as reported across all sources, encompasses a mere 64.18 lakh hectares, representing a mere 42.57 percent of the total cultivated land (RKVY, 2011). The average annual rainfall in the region stands at 857.70 mm, with a significant portion exceeding 60% lost as run-off, a stark indicator of the insufficient irrigation infrastructure, leading to a decrement in production rates (RKVY, 2011).

The distribution of irrigation sources within the state further underscores the challenge. Canals contribute to only 10.51 percent of the total irrigated area, while well and tube wells account for 42.56 percent, other minor sources make up 9.73 percent, and tanks constitute a mere 1.38 percent (MPWRD, 2017). Despite substantial efforts to augment the irrigated land area through the construction of extensive irrigation dams, their impact has been limited, providing irrigation to only 10.51 lakh hectares of land (MPWRD, 2017). Moreover, the reach of dams is restricted to specific downstream areas via canal systems, thereby leaving remote regions devoid of river-based irrigation facilities.

In response to this pressing concern, the state has implemented Minor Irrigation Schemes, particularly the utilization of Tube wells, and Micro Minor Irrigation Schemes, encompassing the establishment of Micro-Minor Irrigation Tanks (MIT) and Percolation Tanks (PT). During the 10th Five-Year Plan, this initiative yielded 128 MITs and 763 percolation tanks, consequently expanding irrigation coverage by an additional 101341.28 hectares. However, it is important to note that the allocation for the State Sector Scheme during this period was notably modest, with a budget of Rs 6025.28 lakhs, which proved insufficient to cater to the needs of large-scale growers (MPWRD 2., 2010).

Turning to the latest data available as of 2021 from the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), it is evident that a mere 887 hectares are covered by drip irrigation, while an additional 882 hectares benefit from the implementation of sprinkler techniques in Madhya Pradesh (PMKSY, 2021). This snapshot underscores the ongoing challenges in achieving comprehensive and equitable irrigation coverage within the state.

Challenges Associated with marketing of Organic Products of Madhya Pradesh

According to a Business World research, despite having the most organic farming acreage in the world, the Indian populace only consumes less than 1 percent of all organic vegetables.

Facilitating Marketing of Organic Produce:

The Jaivik Kheti portal stands as a unique and pioneering endeavour orchestrated by the Ministry of Agriculture (MoA), the Department of Agriculture (DAC), and MSTC with the overarching objective of propagating organic farming practices on a global scale. It constitutes an inclusive platform tailored to the needs of organic farmers, serving as a comprehensive marketplace for the trading of their organic produce, while concurrently propagating the manifold advantages of embracing organic cultivation. The portal provides an array of resources, encompassing case studies, instructional videos, best-practice guidelines, success narratives, and other informative materials germane to organic farming, carefully designed to facilitate and promote this sustainable farming paradigm.

Notably, the pricing structure offered through the portal renders door-to-door services accessible to farmers at a substantially reduced cost compared to prevailing market alternatives. This platform, conceived to foster the comprehensive growth and dissemination of organic farming, fosters crucial connections among diverse stakeholders, including regional councils, local farmer groups, individual farmers, buyers, government agencies, and input suppliers. Through various price discovery mechanisms, such as forward auctions, price-quantity bidding, book building, and reverse auctions, the portal plays an instrumental role in assisting farmers in obtaining the most favourable prices for their organic products, thus elevating the economic prospects of the agricultural community.

However, an earnest evaluation suggests that while these initiatives hold promise, their realization necessitates a broader and more comprehensive approach, particularly in the context of India's agricultural landscape. Empirical data highlight the preponderance of small and marginal farmers in the Indian agricultural sector, many of whom possess limited educational attainment, primarily at the matriculate level or below, and lack familiarity with contemporary technological concepts such as Internet of Things (IoT) and Artificial Intelligence (AI). Thus, to yield more impactful results, it is imperative for the government to prioritize the enhancement of technical education and digital literacy among these farmers, ensuring they can fully leverage the potential of these technologies.

To this end, targeted training programs focusing on value addition and organic produce marketing, conducted through participation in Organic Trade Fairs, such as the Rashtriya Krishi Samridhi Mela, Krishi Unnati Mela, District/State Melas, and the Organic World Congress, have proven quite fruitful. The deployment of organic stalls at diverse Krishi Fairs, hosted at institutions such as Grameen Haat, the College of Agriculture in Indore, and the Indian Institute of Soyabean Research in Indore, has further advanced the cause of promoting organic produce, while concurrently fostering awareness of organic products' utility and benefits.

An exemplary illustration of grassroot level efforts is the establishment of the "Anant Mandi" free market/hat in 2019, a commendable initiative driven by the young populace in Madhya Pradesh, particularly those hailing from the Bhopal district. Initiated by two enterprising young women, this endeavour has thrived for over three years, providing a direct channel for local organic farmers and artisans to sell their wares to end customers, eliminating the need for intermediaries and their associated fees. "Anant Mandi" serves as a pivotal junction, bridging the gap between farmers and consumers, wherein the demand

eliminating the need for intermediaries and their associated fees. "Anant Mandi" serves as a pivotal junction, bridging the gap between farmers and consumers, wherein the demand and supply of organic products harmoniously converge (Verma, 2020). These collaborative measures, both from the government and the local populace, stand as commendable steps towards the wider adoption and promotion of organic farming, signifying an ongoing commitment to nurturing this vital sector of agriculture.

The adoption rate of organic farming

We tried to study the adoption rates of organic farming practices with the help of organic area and in conversion area in Madhya Pradesh. This helps to the extent to which organic area contributes more and in which year there is more area covered under organic farming in Madhya Pradesh.

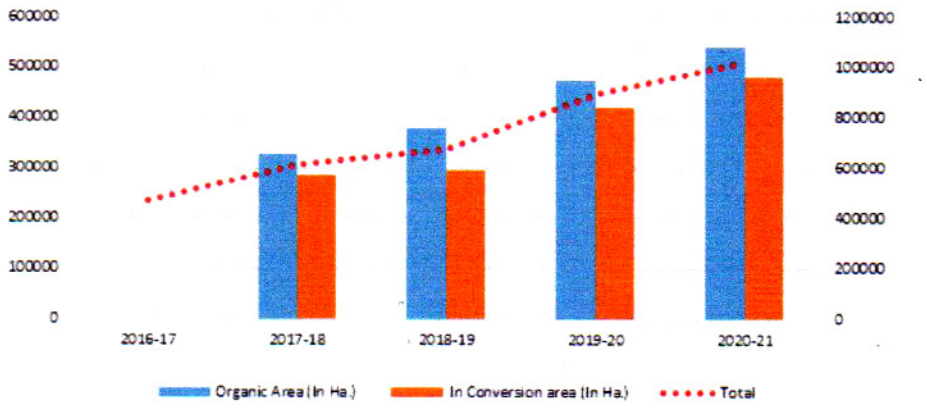
Table-3: Year wise cultivated farm area under organic farming (in Madhya Pradesh)

Year	Organic Area (In Ha.)	In Conversion area (In Ha.)	Total area Organic Area + In Conversion area	Total area increase (in %)
2016-17	-	-	464,859.43	-
2017-18	328,420.53	284,974.92	613,395.45	13.77
2018-19	379,996.68	294,055.16	674,051.85	4.71
2019-20	473,522.47	419,373.94	892,896.41	13.96
2020-21	540,993.98	479,024.00	1,020,017.98	6.64

Source : APEDA, consolidated organic agricultural statistics

Figure 3

Year wise cultivated farm area under organic farming (in Madhya Pradesh)



A progressive expansion in the area dedicated to organic farming with each passing year wherein a discernible upward trend is evident in the conversion rate of conventional method to organic method. Notably, the trend line for the total cultivated area devoted to organic farming demonstrates a consistent rise from the fiscal year 2016-17 to 2020-21. Based on these empirical observations, it is reasonable to conclude that the adoption rate of organic farming practices continues to increase within the region of Madhya Pradesh.

Conclusion:

Emerging Situation of Organic Farming in Madhya Pradesh provides a comprehensive overview of the trends in organic farm production, contribution to exports, irrigation facilities, challenges in marketing, and the adoption rates of organic farming practices in Madhya Pradesh. The state has emerged as a leading contributor to India's organic produce market, with impressive growth in production and a significant role in the country's organic exports.

Despite facing challenges in irrigation facilities, Madhya Pradesh has made strides in expanding its organic farming sector. Efforts such as the JaivikKheti portal and grassroots initiatives like "Anant Mandi" have played a crucial role in facilitating the marketing of organic produce and bridging the gap between farmers and consumers.

The study also highlights a positive trend in the adoption rates of organic farming practices, with a consistent increase in the area dedicated to organic farming over the years. This indicates a growing acceptance and recognition of the benefits of organic agriculture in Madhya Pradesh.

Overall, the findings of this study underscore the significant progress and potential of organic farming in Madhya Pradesh, emphasizing the need for continued support, technical education, and digital literacy initiatives to further enhance the sustainability and economic prospects of the agricultural community in the state.

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MODELLING FOREIGN DIRECT INVESTMENT (INWARD AND OUTWARD) AND GROSS FIXED CAPITAL FORMATION (GFCF) IN INDIA

Dikshita Kakoti[*]

Abstract

This paper explores the most significant question of what connection, if any, exists between Gross fixed capital formation (Domestic investment) and Foreign direct investment (both inflows and outflows) in India during the period 1990-2022. Even though this question has great importance from an economic policy point of view, still there has been little to no empirical investigation taken so far in the case of emerging economies like India. Thus, by utilizing single-break unit root and co-integration analysis, this study finds a stable long-run relationship among the selected variables, including the vector error correction model (VECM) used to test both the short-run and long-run association. When conducting time series data analysis, it is crucial to assess the order of integration for the variables. Given the relatively low control of unit root tests, this study used a variety of tests, including Augmented Dickey-Fuller (ADF) and Phillips-Perron non-parametric test (PP) unit root tests, as well as the fewer known (positive) Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Zivot-Andrews single-break unit root tests are used examine the order of integration of the concerned series. Later on, the Johanson co-integration and Pair-wise Granger causality tests are used to check their causal relation.

JEL Code: C22, F21, O52.

Keywords: Pairwise Granger causality test, Vector error correction model (VECM), inward and outward foreign direct investment (FDI), Gross fixed capital formation (GFCF), Johansen co-integration test, KPSS unit root test, vector error correction model (VECM), Zivot-Andrews single break unit root test.

Introduction

India has experienced a mixed record when it comes to leveraging foreign direct investment (FDI) inflows for sustainable economic development. However, a relatively

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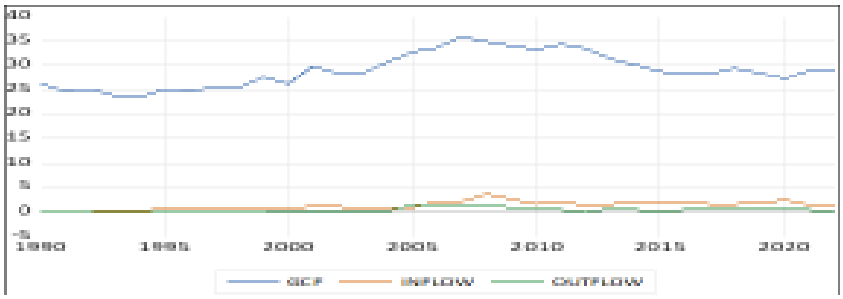
new trend in the country is the increase in outward FDI (OFDI) flows. The implementation of economic liberalization policies in 1991, including industrial deregulation, trade liberalization, and relaxation of inward FDI regulations, has enhanced the competitiveness of many Indian firms. As a result, these firms have been encouraged to engage in OFDI through joint ventures and wholly-owned subsidiaries. Alongside private sector initiatives, state-owned enterprises in India have also participated in Greenfield OFDI. Domestic investment and inward FDI are two interconnected components of a country's economic landscape. When a country attracts significant inward FDI (INFDI), it can lead to increase the domestic investment. Foreign companies investing in a country often require local suppliers, infrastructure, and services which can create opportunities for domestic businesses to expand and invest. Since its introduction in June 2000, the Foreign Exchange Management Act (FEMA) has significantly expanded the opportunities for Outward Foreign Direct Investment (OFDI) from India. Over the years, there have been substantial revisions to OFDI policies. In 2002, the annual upper limit for automatic approval was increased to $100 million. In March 2003, the ceiling was further relaxed, allowing Indian participants in the OFDI process to invest up to 100 per cent of their net worth. In 1980, the domestic investment-GDP ratio stood at a moderate level of 17.9 per cent. According to Panagariya (2003), the relaxation of regulations in the Indian industry began in the early 1970s, followed by trade liberalization in the late 1970s. However, it was not until 1985 that the pace of reform significantly accelerated, with substantial liberalizing measures implemented during the latter half of the 1980s (Dasgupta, 2015). Figure 1 shows the growing trend of GCF and FDI (inward and outward) as a percentage of GDP is shown.

Figure 1: Trend of FDI (inward and outward) and Domestic investment (GFCF) as a percentage of GDP in India (1990-2022)



Source: Author's compilation based on secondary data

Gross capital formation (domestic investment) covers the outlays on addition to the fixed assets of the economy and net changes in the level of inventories. Meanwhile, foreign direct investment (FDI) relates to financing the purchase of shares in foreign companies, the buyer has an eternal interest (10 per cent or more depending on voting stock). Thus, FDI can be used to finance fixed capital formation along with a deficit in the company or pay off a loan. According to OECD Outlook 2023, Gross fixed capital formation (GFCF), also known as "investment", is defined as the '*acquisition of produced assets (including purchases of second-hand assets), including the production of such assets by producers for their use, minus disposals. The relevant assets relate to assets that are intended for use in the production of other goods and services for more than a year. The term "produced assets" means that only those assets that come into existence as a result of a production process are included. It, therefore, does not include, for example, the purchase of land and natural resources'.*

After the liberalization of India's OFDI regime from protection and supportive industrial and technology policies, the early 1990s played a very considerable role in augmenting OFDI. However, even now, OFDI flow from India is small compared to other emerging economies, reflecting India's doubt about allowing outward FDI on a larger scale. Recent mergers and acquisitions of foreign firms by prominent Indian business houses such as Dabur, Tatas, Wipro, Infosys, etc. have ignited economic & political as well as academic interest in the practice of Indian OFDI. All these lead to high technology-based knowledge-intensive industries such as pharmaceuticals and ICT services. Considering all these aspects, This study contributes to research by testing whether the relationship between FDI (inward and outward) and Domestic investment exists or not. This distinction between inward and outward FDI is essential, as various theoretical models and empirical results have recommended that the effect of FDI on DI is linear. Furthermore, India is considered to be the fastest-growing emerging economy in the world. Therefore, an attempt has been made to examine the direction of causality and asymmetric speed of adjustment between selected variables which is supposed to be an improved approach to the previous methodology of the traditional adjustment methods.

The rest of the paper is structured as follows. Section 2 summarizes the review of the literature. Section 3 discusses the definition and sources of data used and the methodology. Section 4 presents empirical results and their interpretations. Finally, Section 5 discusses the concluding remarks.

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Related literature

Economic theory suggests in the case of developing countries increase in FDI leads to a rise in their stock of capital or private capital formation as well that, in turn, raises the labor productivity in the home country and income growth simultaneously. This process eventually transforms into higher levels of output by creating employment and rise possible tax revenues. Again, increases in the stock of public capital like expenditures on roads, highways, bridges, and ports—expenditures that balance rather than alternate for private capital formation (Aschauer, 1989; Ramirez, 1994). Much literature has found that negative effect on the growth prospects of a country if they give rise to considerable reverse flows in the form of remittances of profits and dividends or if the TNCs obtain substantial tax or other concessions from the host country. It became worse if the anticipated positive spillover effects from the transfer of technology due to FDI are minimized or eliminated because of the inappropriate technology transfer for the host country's factor proportions (e.g., too capital-intensive or labor-intensive); or, as a result of overly preventive 'intellectual property rights' and/or prohibitive royalty payments and rental fees charged by the TNCs for making use of these "intangibles" (Ram & Zhang, 2002). The empirical literature on Outward FDI and Domestic investment association is comparatively limited in the case of developing economies but abundant from the perspective of developed economies (Li et al. 2016; Yo and Solomon 2015; and Al-Sadiq 2013). Ibrahim et al.(2014) explore the connection between foreign and domestic investment in Economic growth in Nigeria (1980-2013). By using the Vector Error Correction Model (VECM), found that foreign and domestic investment has a strong control on growth in both the short and long run. In the case of advanced nations, Ali et al. (2019) found that inbound FDI substitutes the DI in China and outbound FDI complements DI which is higher compared to the former. In LDCs, Shah et al. (2020) empirically tested the role of sectoral FDI on Domestic investment in Pakistan from 1980–2012 by using the ARDL model and found that sectoral FDI crowd in the DI in Pakistan. However, it is also mentioned that the results may be different from country to country. Additionally, Islam et al. (2022) examine the impact on domestic investment in Bangladesh by both inward and outward FDI by covering annual time series data from 1976 to 2019. By using an augmented Auto regressive model to anticipate the counterfactual shock of the regressors and their effects on the dependent variable and found that inward FDI has a encouraging impact on domestic investment, while the outward FDI showed in-significant relation in both the long run and the short run respectively. The

same results were found by McNown et al. (2018) and Sam et al. (2019) after adding some other variables like GDP, the real interest rate, and the violation of political rights and their impacts on the dependent variable Gross fixed capital formation in both the long run and the short run respectively. In the case of India, Rath et.al (2014) investigates the dynamic relationship between Private Domestic Investment Foreign Direct Investment (FDI) adding Public Investment (PU) in India by the Using VAR model and found that FDI has crowding effects on PDI and shocks in Pubic investment and PDI have augmented the FDI inflows in India.

In retrospect, many researchers have highlighted the determinants and significance of attracting foreign direct investments (FDI) from different perspectives. But India's outward FDI has attracted little attention from researchers so far as they have measured the outward FDI in terms of commitments or approved equities (Kakoti, 2019). So, given the limited amount of empirical research related to India's outward investment and the lack of macro-level studies to examine the relationship between India's domestic investment (Gross fixed capital formation) and FDI (inward and outward). Considering all these aspects, the present study focuses on empirically studying the co-integrating relationship between FDI (inward and outward) and domestic investment (gross fixed capital formation) in India from 1991-2022 using the Johanson co-integration and pairwise Granger causality test.

Data source and econometric methodology:

This study examines the relationship between FDI (inward and outward) and Domestic investment (gross fixed capital formation) in India from 1991-2022 using time series analysis. The information regarding outward FDI is obtained from UNCTAD Statistics, while the remaining data are acquired from the World Development Indicators. Due to the presence of negative values in some of our data points, we have made the decision not to apply a transformation using natural logarithms. Although natural logarithms have their merits, transforming the negative values into positive ones solely to accommodate the logarithmic transformation, could introduce artificiality into the data, potentially compromising the accuracy of the results. The reason behind choosing the period 1991 is that accurate data on FDI (inward and outward) was not found before pre-liberalization. The growing trend of inward and outward FDI is only visible after Economic reform in India, as well as the growth of domestic investment is also visible only after liberalization. So, in this study, Post liberalization i.e. 1991 data are taken.

Econometric Methodology:

When conducting time series data analysis, it is crucial to assess the order of integration for the variables. Given the relatively low control of unit root tests, this study used a variety of tests, including Augmented Dickey-Fuller (ADF) and Phillips-Perron nonparametric test (PP) unit root tests, as well as the fewer known (positive) Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationary test to examine the order of integration of the concerned series. The appropriate lags were determined via the E-views 12.0 default procedure (in our case it is 1), using the more robust Akaike Information Criteria AIC as a criterion. Meanwhile, Zivot-Andrews single-break unit root tests are used as the power of unit root tests is reduced considerably when the stationary choice is true and a possible structural break is ignored. For all the selected variables (GCF, INFDI, OUTFDI), the results are shown in Table 1 with the same general conclusion, that all the variables at levels are nonstationary but after the first difference they became stationary.

For analysis, we consider the following function considering the three macro factors:

DI (GFCF) = f (INFDI, OUTFDI)

Two well-liked unit root test has been applied to check the stationary i.e. Augmented Dicky Fuller (ADF) and Phillip-Perron (PP) test. The equation for the ADF test is:

The lag length of ADF is selected based on Akaike Information Criteria (AIC). Later on, Phillips and Perron's test is used, which is a nonparametric statistical method of unit root test to check the serial correlation in the error terms without adding lagged difference terms like the ADF test. The Phillips-Perron (PP) test considers the following regression equation:

$$\Delta y_t = \propto_1 + \beta_1 T + \pi_1 y_t + u_{1t}$$

For investigating the association between macroeconomic variables, the Johansen co-integration test is used. Then pair-wise Granger causality test is used to check the short-run causal relationship between the variables indicates the lag values of a variable can help in the prediction of another variable of the model. It estimates the subsequent pair of regressions:

$$x_t = \sum_{t=1}^{n} \alpha_i y_t + \sum_{j=1}^{n} x_{t-1} + u_{1t}$$

$$y_t = \sum_{i=1}^{n} \alpha_1 y_t + \sum_{i=1}^{n} \delta_j x_{t-1} + u_{2t}$$

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The first equation indicates that variable X is related to the past values of itself as well as that of variable Y and the second equation assumes a similar case of Y. From the equations, the relationship has been distinguished into four cases namely, un-unidirectional causality from X to Y, un-unidirectional causality from Y to X, Bi-lateral causality and no causality i.e. when the variable coefficients are significantly different from zero (Kakoti, 2019)

Table 1: Unit root test results

Variable	Augmented Dicky Fuller Test (ADF)		Phillips-Perron Test (PP)		Kwiatkowski-Phillips-Schmidt-Shin test (KPSS)		Zivot-Andrews single break test (ZA)	
	Level	1st difference	Levels	1st difference	Level	1st difference	Levels	1st difference
GFCF	1.00 (.99)	-4.96 (.0004***)	1.55 (.99)	-4.88 (.0005***)	.93 (.01**)	.97 (.000)***	-3.43 (.65)	-4.99 (.000)***
INFDI	-0.99 (.74)	-5.81 (.000***)	-0.76 (.81)	-6.28 (.000***)	-.208 (.45)	.78 (.98)	-3.99 (.88)	-3.76 (.003)***
OUTFDI	-1.44 (.54)	-5.92 (.000***)	-1.39 (.57)	-5.92 (.000***)	-1.86 (.68)	-.278 (.09)	-2.78 (.23)	-1.76 (.002)***

Source: Author's calculations.

Note: Represents the rejection of Ho at 0.05 per cent of significance.Figures in the ( ) brackets of the ADF test indicate the Mackinnon (1996) one-sided p values for the rejection of Ho. Figures in the ( ) brackets of the PP test indicate the Mackinnon (1996) one-sided p values for rejection of Ho. * denotes a significance of 10%, ** stands for 5% and *** is for 1%.

Empirical results:

Johansen Co-integration Test:

Johansen's test of co-integration is used to check the co-integration among the selected variable by taking the null hypothesis (H_0 : there is no co-integration between the variables under consideration). Unlike the Engle-Granger test, the Johansen test provides the advantage of allowing for the detection of more than one co-integrating relationship. (Johansen, S.,1991). Later on, the optimum lag length for this model is based on VAR Lag length criteria as 1. (Appendix 1)

Table 2: Johansen co-integration test results

Lags interval (in first difference):1 to 1

Unrestricted co-integration Rank test (trace)

Hypothesized No. of CE (s)	Eigenvalue	Trace statistic	0.05 Critical value	Prob.**
None*	0.508850	36.72705	29.79707	0.0068
At most 1*	0.377144	15.39689	15.49471	0.0317
At most 2	0.039009	1.193703	3.841465	0.2746
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE (s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical value	Prob.**
None*	0.508850	21.33015	21.13162	0.0469
At most 1*	0.377144	14.20319	14.26460	0.0411
At most 2	0.039009	1.193703	3.841465	0.2746
Unrestricted Co-integrating Coefficients (normalized by b'*S11*b=I)				
GCF	INFLOW	OUTFLOW		
-9.53E-12	0.000155	4.60E-05		
1.03E-11	-0.000194	0.000287		
-3.79E-12	-3.66E-05	0.000176		

Source: Author's calculation

Note: Max-Eigen value test indicates 2 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 2 shows that there are two co-integrating vectors for the selected variable at a significance level of 5%. Later on CUSUM (Cumulative sum of recursive residual) graph is used to check the stability of the model. It is seen that the residual plot is within the area of two critical lines at a 5% significance level. So we consider the selected model is stable. (Appendix) The result of Figure 3 shows that the error correction term i.e. ECM (-1) is negative and significant. Its coefficient implies that the speed of adjustment to equilibrium is high.

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Table 3: Vector Error Correction Estimates

Error correction	D (GCF)	D (INFLOW)	D (OUTFLOW)
Co-integrating Eq 1	**-0.448292**	8.18E-08	1.21E-08
D (GCF (-1))	0.293375	1.66E-08	2.62E-08
D (GCF (-2))	-0.012297	-6.26E-08	-5.80E-08
D (INFLOW (-1))	-2894558	0.563220	0.374467
D (INFLOW (-2))	-1064282	0.245166	0.027658
D (OUTFLOW(-1))	1116488	0.251679	-0.404523
D(OUTFLOW(-2))	-1703582	0.595588	0.054679
C	3.11E+10	682.9760	637.3158
Residual Diagnostic			
Experiment	**Null hypothesis**	**P-values**	**Results**
Normality	Normally distributed	0.000	Reject the Ho
Autocorrelation	No autocorrelation	.256	Cannot reject the Ho
Heteroscedasticity	No heteroscedasticity	.7382	Cannot reject the Ho

Source: Author's Calculations.

The residual diagnostic verified the validity of the representation of the data for which we have run tests for normality, Autocorrelation, and Heteroscedasticity. The residual diagnostic results show that our model satisfies two assumptions, but this fails in the normality test as India's OFDI was very low or insignificant before liberalization.

The Granger causality test:

As we have found more than one co-integrating vectors, then a suitable inference technique is the pairwise Granger causality test to check the pairwise co-integration among the selected variable in the short run. The following table shows the pairwise test results.

Table 5: Granger causality test results

Lags: 1lags

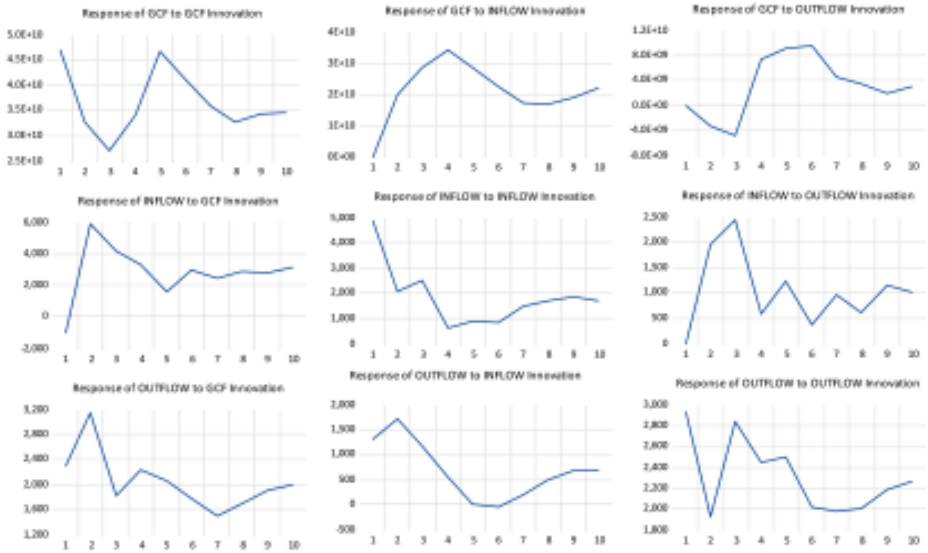
Null hypothesis	Probability	Results
INFLOW does not Granger Cause GCF	0.0145**	Reject
GCF does not Granger Cause INFLOW	0.0002***	Reject
OUTFLOW does not Granger Cause GCF	0.5967	Accept
GCF does not Granger Cause OUTFLOW	0.4396	Accept
OUTFLOW does not Granger Cause INFLOW	0.0283**	Reject
INFLOW does not Granger Cause OUTFLOW	0.0467**	Reject

Source: Author's calculations.

Note: At level 0.10=*, 0.05=**, 0.01=*** it indicates reject the null hypothesis.

Table 5, it is seen two pair-wise causal relationships i.e., FDI inflow and Gross fixed capital formation, FDI Outflow, and FDI Inflow as the null hypothesis is rejected at 5 per cent, 1 per cent and 10 per cent respectively. But for the GCF and FDI outflow, there is no causal relationship among the variable in the short run. In general, the short-run impulse response functions are consistent with the VECM and Johansen tests, except for Outward FDI shown in Figure 2.

Figure 2: Response to Generalized One S.D. Innovation (degrees of freedom adjusted)



Source : Derived from system

Conclusion:

Developing countries have been facing difficulties in promoting FDI due to deficiency of financial resources and technology skills. At present, FDI has become the centre of consideration for policymakers in developing and emerging countries like India. What we need is a changing policy towards FDI by proving incentives to foreign investors. India's ability to attract foreign direct investment (FDI) during the post-liberalization period has witnessed relatively low leap compared to other developing countries. This is mainly due to factors such as a poor investment climate, inadequate infrastructure and fluctuating foreign exchange rates.

The main aim of the study is to empirically investigate the impact of inward and outward FDI on India's domestic investment (GFCF) covering the period 1991 to 2022. Augmented Dickey-Fuller (ADF) and Phillips-Perron non-parametric test (PP) unit root tests, as well as the fewer known (positive) Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Zivot-Andrews single-break unit root tests, are used examine the order of integration of the concerned series. Later on, Johanson co-integration and Pair-wise Granger causality test is used to shed light on the short-run causal relationship and established both long-run and short-run association among the variables concerned. Furthermore, the theoretical implications of the study advocate the fact that Indian FDI inflows and outflows do not chase the traditional theories of FDI. Future researchers can build new theories which can explain more adequately the various pull and push factors for encouraging India's domestic investment (GFCF) by raising both inflows and outflows from India. However, This study is not without its limitations. The study has only considered three macroeconomic variables, namely, foreign direct investment (inward and outward) gross and gross fixed capital formation. Some other relevant macroeconomic variables especially real effective exchange rate, trade openness rate, and inflation can be used in future research Further, the study is based on annual observations; analyses based on quarterly data may capture different results.

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Appendix:

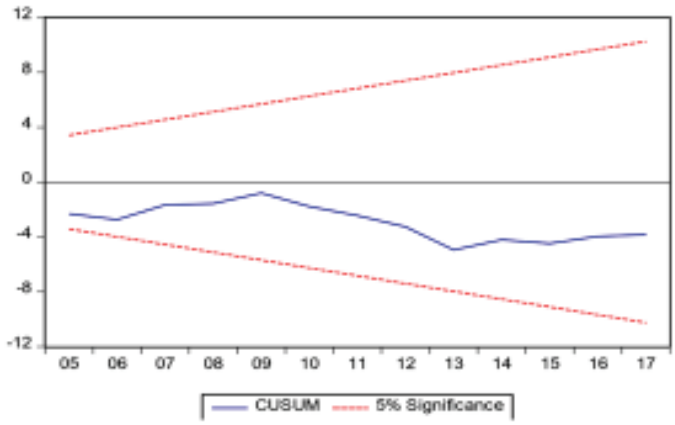
VAR lag length criteria

VAR Lag Order Selection Criteria
Endogenous variables: GCF INFLOW OUTFLOW
Exogenous variables: C
Date: 07/07/23 Time: 11:09
Sample: 1991 2022
Included observations: 30

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1434.710	NA	8.48e+37	95.84734	95.98746	95.89216
1	-1353.521	140.7280*	6.93e+35	91.03472	91.59520*	91.21402*
2	-1343.867	14.80304	6.78e+35*	90.99111*	91.97195	91.30489

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Stability (CUSUM) test



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ECONOMIC ANALYSIS OF AGARWOOD CULTIVATION IN ASSAM: AN EMPIRICAL INVESTIGATION

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Abstract:

Agarwood, a highly valuable fragrant wood of Aquilaria spp. has been widely used in perfumes, traditional medicine, religious rites and cultural activities. Due to the presence of aromatic and medicinal properties, the Agarwood has gained its economic importance in recent years. It has been providing livelihood and employment facilities to many people who are cultivating those. Owing to high demand and profitability, the people of Assam has started to cultivate Agarwood in a commercial manner in recent days. This study was conducted to examine the economic viability of Agarwood cultivation in Assam and to understand the problems of the cultivators to consider Agarwood cultivation as the primary source of income. The primary data were collected during the months of May and June, 2022 from 210 households using structured questionnaire. The cost-benefit analysis revealed that INR 100 of initial investment yields a net benefit of INR 623 which indicates that the return from the Agarwood cultivation among the cultivators are very high. Thus, the present study argues that the government should encourage the cultivators by providing the necessary support in the form of a legalized market, credit requirement, creating the awareness about the demand of Agarwood and making provision of training.

Key Words: Agarwood, Economic Viability, Net Present Value, Benefit Cost Ratio, Internal Rate of Return & Upper Assam

JEL Codes: Q10, Q13, Q14, Q18, C81

Introduction:

Aromatic plants play an important role among the mankind since the pre-historic time due to its aroma and medicinal use (Inoue et al., 2019). Today, medicinal and aromatic

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plants have contributed significantly towards employment creation and income generation among the underprivileged people and thereby economic development especially in the biodiversity rich developing countries of the world (Myers, 1990; Richman, 2002; Taghouti et al, 2021; Weiss et al, 2020). According to a report by Market Research Future, the value of aromatic market is estimated at USD 200.9 billion in 2022 and is projected to increase to USD 328.1 billion by 2032 with a compounding growth rate of 5.60 per cent for the forecasted period[1]. On the other hand, the estimated annual growth of global medicinal and aromatic plants market is around 10-20 per cent and is expected to reach $ 5 trillion to $ 7 trillion by 2050 (Silalahi et al, 2023). Thus, with ever growing demand for both medicinal and aromatic plant-based products there is a scope to consider cultivation of aromatic plants as an additional source of livelihoods and thereby to provide economic benefits to the poor (Guleria et al., 2014). In a country like India, therefore, the economic importance of the aromatic and medicinal plants never be denied. Assam falls under one of the biodiversity hotspots of the world is home to many aromatic and medicinal plants. Agarwood is one of such aromatic plants cultivated by the farmers widely in many parts of Assam. Of late owing to the growing global demand, people of Assam started to cultivate agarwood commercially.

Agarwood, locally known as *Agar* in Hindi, *Agaru* in Sanskrit, and *Xashi* in Assamese, is a highly prized tree for its fragrant dark resinous content formed as a result of injury and fungal infection (Ahmed & Bhagabati, 2021). It is one of the species of Aquilaria (*Aquilaria malaccensis* Lamk) of the family Thymelaeaceae. (Mamat et al. 2010) and among all the species of *Aquilaria,* the *Aquilaria malaccensis* Lamk is the principal source of Agarwood (Sarkar, 2019). Other agarwood-producing species are *Aquilaria crassna, Aquilaria agallocha, Aquilaria sinensis, Aquilaria filaria* and *Aquilaria subintegra*.

For thousands of years, Agarwood has been used for medical, aromatic and religious purposes in the Middle East and in India. The high economic value of Agarwood had drawn great attention for *Aquilaria* from different societies around the world. In Arabian society, Agarwood was mainly demanded for perfumery use, in Indian society, the demand was increased for its religious application. The use and trade of Agarwood have had a rich history in India and it was also considered to be of great commercial value. In the *Arthashastra*, Agarwood and other aromatics were also subject to a state tax at one-tenth or one-fifteenth of the sale price of the products (Lopez-Sampson & Page, 2018). A study done by Lopez-Sampson & Page (2018) stated that wild Agarwood was used for the

[1] https://www.marketresearchfuture.com/reports/aromatics-market-930.

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cremation of priests and princes and thus confirmed the high of this at that time. In India, the trade based on Agarwood is mainly derived from *A. Malaccensis;* and for a long-time trade in Agarwood and its products has been a monopoly of the country. The production and trade in Agarwood products included wood, chips, powder and oil which were used for mainly perfumes, incense and medicines including Ayurvedic, Chinese, Malay and Tibetian (Chakrabarty et al., 1994; Ali et al., 2016). High grade agarwood powder is used in Chinese medicine for the production of pharmaceutical tinctures. In Bangladesh, it is used to treat rheumatism; in Malayasia for the treatment of stomach pain in pregnancy, after delivery, fever, rheumatism, body pains, women diseases, small pox and dropsy (Gimlet, 1930; Burkill, 1966; Chakrabarty et. al., 1994). It is also used traditionally to treat snake bite, vomiting, paralysis, diarrhea and others. In East Asia, it is used as sedative, analgesic and digestive medicine. Further, in middle east, agarwood is a symbol of status, wealth and hospitality (Chang et. al., 2002). The Agarwood is also used in toiletry products such as soap and shampoo; used as writing material; used as incense stick etc. (Chakrabarty et. al., 1994). Further, due to its therapeutic properties, agarwood oil is widely used in aroma therapy. Many pharmacological studies have also been completed and found agar as anti-depressant (Takemoto et al., 2008), anti-cancer (Dahham et al., 2016), anti-inflammatory (Chitre et al., 2007), anti-diabetic (Feng et al., 2011; Pranakham et al., 2015) and anti-oxidant (Tay et al., 2014). Because of such studies, importance of Agarwood has increased further.

The demand for agarwood oil has been increasing continuously due to its wide varieties of uses. As per reports Indian Agarwood Oil extracted from the Agar trees of the North East India, specially from Assam are the most expensive amongst the available varieties of agarwood. Due to the presence of high-quality agarwood in the state, Assam is also known as the Agarwood capital of India. The Agarwood chips per kg costs between USD 1000 to USD 5000; while the pure grade Agarwood oil varies between USD 32000 to USD 40000. Extensive medicinal, aromatic and religious uses made it is the most expensive wood in the world and for which the agarwood is also known as the "Wood of the Gods" or "God's Wood" (Mir et al., 2017). However, due to high economic value of the Agarwood, people used to harvest the plant indiscriminately which led to drastic fall in the number and extent of *Aquilaria malaccensis* in the tropical forests. Moreover, smuggling and poaching of agarwood is adding fuel to the problem. Consequently, it was enlisted in the Appendix II of the Convention on International Trade in Endangered Species of Wild Life Fauna and Flora (CITES) in 1995 to ensure its sustainability (Barden et. al., 2000). This species is

also included in the red data list of the IUCN (Harvey-Brown, 2018). On the other hand, in India, *Aquilaria malaccensis* is considered critically endangered and thereby the government of India has restricted the import of Agarwood and regulated the export of Agarwood from India. However, even then in India, especially in North East India, the sale and purchase of the Agarwood has been continued and cater the need of the people at the time of adversity.

The North-Eastern States mainly Assam is the home of *A. malaccensis* which is basically harvested in the homestead of the Upper Assam, especially by the people of Golaghat, Jorhat and Sivasagar district along with other useful plants (Saikia & Khan, 2013). It is also found in Hojai, Cachar and Karimganj Districts. While the extraction, distillation and primary processing are primarily carried out at Hojai; and from Mumbai it is traded and exported. Many numbers of small-scale agar industries are also operating in some districts of Assam providing a livelihood opportunity to the local people (Chakrabarty et al., 1994).

Thus, due to high economic potential, Agarwood cultivation in Assam and the adjoining parts of Northeast India has received significant importance in recent years (Saikia & Khan, 2013; 2014). Agarwood trees and Agarwood-based products could be the ones through which a great amount of return is possible. Considering the uses and high economic value of Agarwood, the people of Assam have started to grow this species in their home gardens as well. Gradually, commercial planting of Agarwood has also started in upper Assam. Moreover, People of Assam consider planting of Agarwood in their homestead as the Life Insurance. Further, studies revealed that Agarwood has great economic prospects in the home gardens of Upper Assam and home gardens be used for the conservational purpose of the Agarwood trees (Saikia & Khan, 2014). The government of Assam has also recognized the importance of such home gardens to bring economic prosperity among the rural people. And considering the importance of Agarwood cultivation, the government of Assam notified "The Assam Agarwood Promotion Policy, 2020" to ensure agarwood's sustainable utilization and trade. The policy intended to promote research on sustainable harvesting of the species and cultivation practices.

With this background and limited existing literature, the study is undertaken to understand the economic profitability of Agarwood cultivation in Assam. Further, the Agarwood tree growers have faced many problems with agar cultivation and its marketing. Therefore, there is also the need to study the problems associated with both Agarwood cultivation and its marketing. Hence, the present study is about to assess the economic viability of Agarwood cultivation and to study the problems associated both with Agarwood

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cultivation and its marketing. It is expected that the findings of the study will be helpful to the Agarwood growers, researchers and policy makers to make right decisions regarding the cultivation, production, marketing, and policy formulation of Agarwood in Assam.

Materials & Methodology:

The present study uses both the primary and secondary data for the analysis. However, for the analysis, primary data is mostly used. Secondary data is used only when required. For the present study, three districts of Upper Assam, viz., Golaghat, Jorhat and Sivasagar is considered purposively to carry out the research work as Agarwood cultivation is mainly concentrated in three districts of Upper Assam. After selection of the districts, blocks and villages are selected purposively based on pilot survey and data provided by the village headman and officials from the blocks. In the last stage, as reliable data on the exact number of Agarwood growers in Assam are not available which makes it difficult to locate the target population. Therefore, snowball sampling method was employed to select the samples. Once the samples are selected, using structured questionnaire data are collected. The figure 1 shows the districts of Assam and the selected area for the study.

A total of 70 sample growers were selected from each of the districts and the total number of selected sample growers became 210. The primary data were collected through a structured interaction with the sample growers by providing questionnaires. These data were collected during May to June 2022.

Figure 1: District map of Assam. The map is modified from the www.mapsofindia.com
● Represents the selected districts Golaghat, Jorhat and Sivasagar

However, secondary data have also been used wherever required. The secondary data was collected from Government publications, works of several authors, Reserve Bank of India Databases etc. Moreover, various books, research journals, research theses, and dissertations were also used to carry out the study. While assessing the economic viability of Agarwood cultivation in Upper Assam financial measures like Net Present Value, Benefit Cost Ratio and Internal Rate of Return is being calculated. And the problems faced by the sample Agarwood growers in the study area were studied through the Garrett Ranking Technique.

Net Present Value (NPV):

NPV is a useful tool to analyze the profitability of a projected investment or project. It can be used for assessing the financial viability which estimates the worthiness of an investment. It is the sum of all cash flows in each period discounted to the present by using the time value of money (Goswami et al. 2019). It is the present worth of net benefits or cash flow stream (Sharma et al. 2014).

The PV of cost is being calculated by using following formula:

$$\text{PV of Cost} = \sum_{t=0}^{n} \frac{E_t}{(1+r)^t}$$

Where, E_t denotes cost (cash outflow) in year t; n denotes investment lifespan; r is the rate of discount rate; t denotes time measured in years.

The PV of benefit is being calculated by using following formula:

PV of Benefit =

B_t denotes benefit (cash inflow) in year t; n denotes investment lifespan; r is the rate of discount rate; t denotes time measured in years.

The NPV or the PV of net benefits is calculated by using the following formula:

NPV =

Where, B_t denotes benefit (cash inflow) in year t ; E_t denotes cost (cash outflow) in year t; n denotes investment lifespan; r is the rate of discount rate; t denotes time measured in years.

In general, any investment is viable if calculated NPV is positive. The zero NPV implies that the investment breaks even.

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Benefit-Cost Ratio (BCR):

The BCR indicates the profitability of any project. It is an indicator showing the relationship between the relative costs and benefits of an investment. The BCR is the ratio of discounted benefits and discounted costs of an investment project (Das et al., 2018). The value of BCR essentially provides the guidance for relative economic justification of an investment project. A project is considered to be viable if the calculated BCR is greater than one. The BCR in the present study is calculated by using the following formula:

$$\text{BCR} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{E_t}{(1+r)^t}}$$

Where, B_t is the benefit at time t; E_t is the cost at time t; and r is the discount rate.

Internal Rate of Return (IRR):

The IRR is the rate of interest at which PV of cost and PV of returns are equal. In other words, it is the rate at which NPV is zero. The higher the IRR, the more profitable the project concerned. Specifically, if the IRR is greater than the discount rate it implies that the investment is viable and smaller IRR than the discount rate implies that the investment is not viable. The following equation represents the relationship between NPV and IRR.

$$\text{NPV} = \sum_{t=0}^{n} \frac{C_t}{(1+IRR)^t}$$

Where, C_t is the cash flow at that point in time.

RESULTS & DISCUSSIONS

Demographic and Socio-economic Profile of the Agarwood Growers

The demographic and socio-economic parameter analysis for the Agarwood growers have also been carried out in the study. The study shows that among the growers 14.29 per cent are belonging to joint family; while 85.71 per cent belong to nuclear family. Out of 1220 number of populations, 49 per cent are female and 51 per cent are male. The average size of the family is 5.81. On the other hand, mean age of the agarwood growers is 47.6 years. Educational status of the Agarwood growers reveals that 96.67 per cent are literate and among them 66.67 per cent have education up to class X. Thus, majority of the respondents are either low skilled or semi-skilled. On the other hand, the study reveals that 78.57 per cent of the agarwood growers have land under Agarwood cultivation is below 7.5 bigha. They are the marginal Agarwood growers. Only 4.76 per cent are the large growers. The average size of the land under the Agarwood cultivation is estimated as 4.76

bigha The Study further reveals that baring few most of the grower have considered Agarwood cultivation along with other source of income. Thus, it is found that 42.86 per cent of the respondents have depended on both agriculture and agarwood as their source of livelihood; while 40.48 per cent consider both Agarwood and business; and the rest 16.66 consider service and agriculture as their source of livelihood. In fact, during the survey it was found that except few, most of the Agarwood growers have cultivated Agar tree as a mixed crop along with either tea or betel nut or vine or pepper. Moreover, it was estimated that average income from 1 bigha of Agarwood was highest for the large growers (INR 1034330) and lowest for the marginal growers (INR 172360). This may be due to longer waiting period to sale their Agar trees to the middleman. Higher the age of the trees more is the value of the Agarwood. Further large growers have devoted exclusively a few Bigha land for Agarwood cultivation (shifting from mixed cropping to mono cropping). Bigger the size of the homestead and agarwood plantation, the more is the agar tree and more the income. This is also found in the study made by Ahmed and Bhagabati (2021).

Table 1: Demographic and Socio-Economic Profile of the Agarwood Growers

Family Profile	
Total number of family members	1220
Percentage of Female members	49
Percentage of male members	51
Average Size of the family	5.81
Nuclear family Joint family	14.29 85.71
Mean age of the Agarwood growers	47.6
Educational Status	
Literate	96.67
Up to Class X	66.67
Between Class X and XII	18.10
Graduate and above	11.90
Land Holdings under Agarwood (in Bigha)*	
Below 7.5 Bigha (Marginal Grower)	78.57
Between 7.5 to 15 Bigha (Small Grower)	16.67
Above 15 Bigha (Large Grower)	4.76
Average size of the land holdings (in Bigha)	4.79
Livelihood Status	
Agriculture and Agarwood Cultivation	42.86
Business and Agarwood Cultivation	40.48
Service and Agarwood Cultivation	16.66
Average income from 1 Bigha of Agarwood Cultivation	
For Marginal Grower	172360
For Small Grower	692916
For Large Grower	1034330

Source: Field study*, 1 Bigha= 0.134 Hectare.

Economic Viability of Agarwood Cultivation:

The benefit-cost analysis (BCA) is usually used as the main tool for assessing the economic viability of a project. This involves expressing the cost and benefits in monetary terms to make comparisons between the two. If at the end of the exercise, the benefit exceeds the cost, the project can be considered to be economically viable and vice-versa. In the context of the Agarwood cultivation also economic viability may be assessed through a benefit-cost analysis (BCA). A BCA is performed by measuring the Present Value (PV), Net Present Value (NPV) Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) criteria as discussed above.

The Agarwood cultivation involves both overhead and variable costs. The overhead costs include clearing of the cite for the cultivation, fencing of the cite and purchasing of the seedlings or production of the seedlings by self. On the other hand, the variable costs include labour (both hired and family) used for cultivation, pruning, weeding, fertilizing and watering; fertilizer occasional fencing of the cite and rent on land. In the study area, rarely artificial wounding was found. The Agarwood cultivators prefer natural fungal infection of the woods over the artificial wounding of the trees and hence no cost involved in the artificial wounding of the trees. Thus, while calculating the costs of Agarwood cultivation all such costs are included and found that the relative cost is more up to age 6 and after that it starts declining (Table 2).

The economic viability for Agarwood cultivation was determined for a farm of 1 bigha (0.134 Hectare) of land for 10 years as the average maturity period of Agarwood trees is ten years according to the sample growers in the study area. Cash outflow, cash inflow and the incremental net benefit (INB) i.e., the net cash flow per bigha of land with their present values for 10 years are shown in Table 1 It is observed that most of the costs of agar cultivation are incurred in the first six years of operation. As the cash flows that occur after ten years may have different meanings in the present day that is why NPV is calculated for ten years by discounting the future cash flows. The choice of discounting rate in this context is very important. Generally, the cost of capital i.e., the lending rate is taken as the discounting rate to calculate NPV. However, it was observed that no sample growers in the study area take credit from the bank to grow Agarwood plants. At the same time, it was observed that the sample growers make savings in banks. Therefore, Savings Deposit Rate is taken as a proxy for the lending rate in the present study to calculate the NPV. The average Savings Deposit Rate of the Reserve Bank of India for the last ten years

(2011-12 to 2020-21) throughout which the Agarwood farmers invested money in Agarwood cultivation was found as 3.76 per cent. Hence for the present study 3.76 per cent is considered as the discounting rate and accordingly, the PV of cash outflows, cash inflows and net cash flows are being estimated (Table 2).

Table 2: Cash Flows in Agarwood Cultivation for 1 bigha of Land (in INR)

Year	Cash Outflow	Cash Inflow	Incremental Net Benefit (INB)	PV of Cash Outflows	PV of Cash Inflows	PV of Incremental Net Benefit (INB)
Establishment Year	12361.1	-	-12361.1	12361.08	-	-12361.1
1	6019.63	-	-6019.63	5801.496	-	-5801.5
2	6019.63	-	-6019.63	5591.264	-	-5591.26
3	4737.33	-	-4737.33	4240.757	-	-4240.76
4	8612.52	-	-8612.52	7430.373	-	-7430.37
5	8665.21	-	-8665.21	7204.921	-	-7204.92
6	7321.27	-	-7321.27	5866.874	-	-5866.87
7	4677.68	-	-4677.68	3612.61	-	-3612.61
8	1208.2	-	-1208.2	899.2893	-	-899.289
9	1208.2	-	-1208.2	866.7013	-	-866.701
10	1208.2	493619.28	492411.1	835.2942	341265.6	340430.3

Source: Field Survey (Author's calculation)

To check the economic viability of Agarwood cultivation for 1 bigha of land, the NPV, B-C ratio and IRR are calculated which are shown in the Table 3.

Table 2: Cash Flows in Agarwood Cultivation for 1 bigha of Land (in INR)

Sl. No.	Particulars	Value
1	Net Present Value	286554.9
2	Benefit Cost Ratio	6.238
3	Internal Rate of Return	33

Source: Field Survey (Author's calculation)

From the table 3, it appears that the NPV calculated at a 3.76 per cent discount rate is INR 286554.9. Similarly, the benefit-cost ratio is 6.238 which mean that INR 100 of initial investment yields a net benefit of INR 623. The IRR is 33 per cent which is very high compared to the required rate of return i.e., 3.76 per cent. The positive values of NPV and IRR and the high BCR confirm the fact that agar cultivation is economically viable in the study area.

Problems Experienced by the Agarwood Growers:

It is found that the Agarwood growers of the study area have a high economic potential for Agarwood production. But although the Agarwood growers have the natural advantage in cultivating those trees at their homesteads, at the same time, they have also faced certain problems with the production as well as in the marketing of Agarwood. This section of the paper is an attempt to identify and recognize the problems faced by the sample Agarwood growers in both cultivation and marketing.

The problems faced by the sample Agarwood growers in the study area were studied through the Garrett Ranking Technique. To find out the most significant problem which had influenced the growers, the respondent's ranks on different problems were converted into the score value with the help of the following formula:

Per cent Position= 100(Rij - .5)/Nij

Where,

Rij = Rank given for the i^{th} variable by the j^{th} respondents

Nij = Number of variables ranked by the j^{th} respondents

With the help of Garrett's Table, the Per cent Position estimated is converted into scores by referring to the table given by Garrett and Woodworth (1969). Then for each problem, the scores of each individual are added and then the total value of scores and mean value of scores are calculated. The problem having the highest mean value is considered to be the most important problem.

Problems Associated with the Cultivation of Agarwood:

The problems associated with the production of Agarwood in the study area are studied and presented in descending order of their relative importance in Table 4 with the help of Garrett's Ranking Technique.

Table 4: Problems Faced By Agarwood Sample Growers in Cultivation

Sl. No.	Problems	Mean Score	Rank
1	Lack of Credit	73.58	1
2	Lack of Training	59.75	2
3	Lack of knowledge about pest and disease	57.49	3
4	High input cost	49.74	4
5	Long waiting period	42.33	5
6	Possibilities of diseases	36.03	6
7	Research & development activities	29.07	7

Source: Field Survey Data (Author's Calculation)

From the above table 4, it is observed that the first and foremost problem identified by the sample growers is the lack of credit for agar cultivation. It is found from the analysis that the lack of credit facilities for Agarwood cultivation is a regular complaint of the Agarwood growers. The financial constraint in any business hinders the path of development. In India, most farmers generally depend on the credit facility provided by the banks to sustain their farming business. It would help the framers with the capital that might not otherwise be available to them. With this capital the farmers can buy the required farming equipment, seeds etc. they need to operate a successful farm. Unfortunately, due to the lack of credit facilities for Agarwood farming; most of the interested farmers find it difficult to adopt this farming practice.

Lack of training was ranked second in order of important problems of Agarwood growers. It is important to have some sort of knowledge of the farming practice. It is evident from the different studies that farmers' pieces of training can help to increase agricultural productivity. For better production, training in agar cultivation and management is very much essential. The farmers should know the methods of cultivating agar and the way to improve their agriculture. The pieces of training improve the skills and knowledge of farmers in planting techniques, applying fertilizer or pesticides etc. But in the study area, it had been observed that the training facilities regarding Agarwood cultivation were lacking which further creates problems for the farmers.

Another important problem met by the sample growers is the lack of knowledge about the pest and diseases of the Agarwood tree. Again, this problem arises mainly due to the lack of training facilities for agar cultivation in the study area. Most farmers do not have proper knowledge about agar farming techniques. Because of the lack of scientific knowledge about farming, many farmers are not able to get the maximum return many a time.

High input cost is another problem met by the Agarwood growers in the study area. In recent years, there has been a phenomenal rise in the price level. The prices of fertilizer, insecticides, Agarwood seedlings etc. also continue to rise and create a financial burden for the growers.

Another important problem identified by the sample growers is the long waiting period for the Agarwood tree to be matured. On average, it takes ten years to mature an Agarwood tree. After that, only the growers can get the minimum return from selling the tree. Thus, the long waiting period to get the return creates a hurdle for the growers. The

possibility of the Agarwood tree being affected by the disease is another problem met by the sample growers. They do not possess scientific knowledge about the possible diseases of Agarwood and its cure. In general, most farmers do not have sufficient knowledge about Agarwood cultivation.

A crucial problem experienced by sample growers is the lack of research and development activities regarding Agarwood cultivation. Due to the lack of research and developmental activities, many farmers don't have the proper knowledge about Agarwood farming.

Problems Faced by Sample Growers in Marketing:

The different marketing problems faced by the Agarwood growers in the study area are also studied through the Garrett Ranking Technique. Table 5 presents the marketing problems identified by sample growers as per the rank assigned by them.

Table 5: Problems Faced by Agarwood Sample Growers in Marketing

Sl. No	Problems	Mean Value	Rank
1	No Regulated Market	68.09	1
2	Do not get actual price from middlemen	59.20	2
3	Rigid Legislation	50.39	3
4	Lack of information	44.82	4
5	Price Fluctuation	25.49	5

Source: Field Survey Data (Author's Calculation)

The first and foremost problem identified by the sample growers is the lack of a regulated market for Agarwood. Due to the lack of a properly regulated market for selling and buying Agarwood chips and logs, the cultivators and the local traders have to depend on traders from outside to sell the Agarwood chips. The second important problem faced by the growers is that due to the existence of middlemen, they sometimes aren't able to get the actual price of their product. The rigid legislation also creates difficulties to sell and transport Agarwood products. Though the government now is removing the restrictions on Agarwood cultivation and its trade, most people are unaware of this. Furthermore, the lack of information about the market price of Agarwood or relating to marketing facilities of Agarwood is another important problem faced by the sample growers. The fluctuating price of Agarwood also impacts the livelihood earnings of Agarwood growers. These constraints are responsible due to why people sometimes do not want to adopt Agarwood farming as their livelihood strategy.

CONCLUSION

The findings of the study suggest that the cultivation of Agarwood is profitable and economically viable. From the economic viability analysis of Agarwood cultivation for a farm of 1 bigha (0.25 Hectare) of land and a period of 10 years, it is estimated that NPV is INR 286554.9 at a 3.76 per cent discount rate, BCR is 6.238 and IRR is 33 per cent which is very high as compared to the required rate of return. The positive NPV value and high IRR indicate that Agarwood cultivation in the study area is economically much beneficial. The high benefit-cost ratio also represents the high profitability of Agarwood farming. Agarwood farming has bright prospects and it would help improve the socio-economic status of the farming community of Upper Assam. To sum it up, the present study found that agar plantation in Upper Assam is economically feasible and can be a genuine opportunity for livelihood to uplift the socio-economic conditions of the people. Fortunately, the agroclimatic condition of the upper part of the state is suitable for growing Agarwood and thus it can be an excellent producer of cultivated Agarwood. The government of Assam should take steps to promote Agarwood cultivation as per its "The Assam Agarwood Promotion Policy, 2020" and take necessary steps to conserve the Agar tree through Agarwood cultivators.

DECLARATION OF INTEREST

The authors have no conflict of interest.

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REASSESSING THE VALIDITY OF ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS: A STUDY OF AFRICAN COUNTRIES

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Abstract:

This study attempted to analyse the validity of the Environmental Kuznets Curve Hypothesis (income-emission relationship) for African countries from 1971 to 2016, incorporating the role of trade openness and population density. The validity of the EKC hypothesis is not confirmed in this study and found an inverse N-shaped relationship between income and emission. It contributes to the current literature by incorporating trade openness and population density in determining the income-emission relationship for African countries. This study recommends further investigation, incorporating other explanatory variables and using other variables to proxy environmental degradation.

Keywords: Environmental Kuznets Curve, CO2 Emission, Trade Openness, GDP per capita, Population Density, Feasible Generalised Least Square (FGLS).

JEL Classifications: C23, O56, Q53.

Introduction:

Climate change and environmental degradation are the topics discussed worldwide by environmentalists, scientists, and policymakers. Carbon-di-oxide (CO_2) is one of the greenhouse gases which contribute to ecological degradation most. Many steps have been taken to cope with the problem of environmental degradation. The Paris Agreement and Kyoto protocol are the two worth-noting global initiatives taken to mitigate environmental degradation.Developed and developing countries signed the Kyoto Protocol to lower current emissions.

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During the 1990s, several studies have been undertaken to study the relationship between economic growth and income redistribution and economic growth and environmental degradation. The former relation is known as the inverted-U hypothesis, and the latter is popularised as Environmental Kuznets Curve. (EKC)

Simon Kuznets proclaimed the first study on the relationship between income growth and income inequality in his paper where he found that with the increase in the per-capita income, the income inequality increases (to a threshold level); after reaching that level, the inequality begins to fall with the increase in the per-capita income which gives inverted-U shaped relation (Kuznets, 1955). Later the income growth and environmental degradation relationship was derived from the inverted U hypothesis of Kuznets, and the work was initiated by Grossman and Krueger (1991). Further, the results such as Shafik and Bandyopadhyay (1992) for the World Bank Development Report of 1992 and Panayotou (1992) significantly popularised the hypothesis. The Environment Kuznets Hypothesis statesthat at the early stage of income growth, the environment degradation tends to increase. Still, environmental quality improves beyond a certain income level per capita and gives inverted-U shape relation between income per capita and environmental degradation. The empirical literature reviewshows the link between economic growth and environmental degradation.

The foremost question addressed in this study is whether income has a significant effect on environmental degradation for African countries. The research gap is expected to be filled through this study by introducing, apart from income, two more independent variables, viz, trade openness and population density, into the model. The panel data model is used to incorporate a large number of countries into the study.

Review of Literature:

Grossman & Krueger (1991, 1995) investigated, in their first attempt, the environmental impact of the North America Free Trade Agreement (NAFTA). The study was done for 42 countries where the relationship between air pollution and income growth was assessed. Their finding confirms the EKC hypothesis.

In the second attempt, Grossman & Krueger (1995) used other variables as environmental quality indicators such as urban air pollution, faecal contamination of river basins, the state of the oxygen regime in river basins, and contamination of river basins by heavy metals from 1977 to 1988. They found a turning point at the income level of around

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$4000-$5000 for smoke. However, the other three pollutants begin to increase with the per capita income of $1000-$15000, resulting from the cubic equation used in their model.
For World Development Report 1992, Shafik & Bandyopadhyay (1992) examined the relationship between the Environment quality and the income per capita for 149 countries from 1960-1990. They found that the lack of sanitation and clean water declined over time with increased per-capita income. However, carbon emission, water pollution, and municipal waste have increased with increased per capita income. The EKC-like relationship is found between income percapita and air pollution.

Panayotou (1993) tested the Environment Kuznets Hypothesis for developing and developed countries using the cross-section data. He found an EKC-type relationship between income per capita and deforestation, and the turning point occurred at per capita income of around $800. The turning point occurred at per capita income of $300 to $4000 for different countries for other pollutants. A similar result (Inverted U relationship between income per capita and deforestation) has been found by Cropper and Griffith (1994) in their paper using panel data for 60 African and Latin American countries. The turning point occurred between per capita income of $4700 and $5400 (in PPP terms).

Selden and Song (1994), in their paper, use the SPM, SO_2, nitrogen oxide (NO_x) and carbon monoxide (CO) as the indicator of air pollution. Also, population density is incorporated in this study. For SO_2 and SPM, the turning points appear above the per capita income level of $8000; this indicates a result supporting the validity of EKC. For the other two pollutants (CO and NO_x), the findings are consistent with the previous findings of the existence of EKC.

Holtz-Eakin and Selden (1995), using panel data of 108 countries, estimated diminishing marginal propensity to emit CO_2 as income increases, suggesting an EKC type of relationship between the variables of income per capita and level of CO_2 emission.

Cole et al. (1997) studied the relationship between income growth and environmental degradation using a panel data approach. Many variables (such as total energy use, nitrates in water, SPM and NO_2, traffic volumes, CFC emissions, and methane and transport emissions of SO_2) have been used to indicate environmental quality. The EKC type relationship has been found between income growth and airpollution. This finding is consistent with Shaik and Bandyopadhyay's (1992) in WDR (1992).

Crarson et al. (1997) examined the existence of EKC for 50 US states for seven years. Seven pollution indicators are considered as indicators of environmental degradation.

They found that all these pollutants decrease with the increase in income level. Their study also found the income-growth relationship that supports the EKC hypothesis.

Roberts & Grimes (1997) have examined the emission of CO_2 per unit of GDP from 1962 to 1991 and tested the inverted U curve relationship for CO_2 emission per unit of GDP. They found that a small number of wealthy nations have achieved an inverted-U relationship.

Schmalensee et al. (1998) have forecasted the long-term climate change through 2050 using the reduced form models estimated using spline regression, the panel data of 141 countries worldwide. In this study, the variable under consideration was Carbon Emission (as dependent variable), population, Gross domestic product and energy consumption. The turning point of EKC is obtained at the income level within the range of $10000 to $17000.

Suri & Chapman (1998) analysed the impact of economic growth, structural change and international trade on commercial energy requirements. The commercial energy requirement is used as a proxy of environmental degradation. Their findings show that the export of manufactured goods by industrialised counties increases the energy requirement and hence is responsible for the upward sloping portion of the EKC. On the other hand, imports by industrialised counties contributed to the downward sloping portion of the EKC.

Galeotri & Lanza (1999) tested three functional specifications for analysing the income and environmental degradation relationship. They have used non-linear Gamma and Weibull specifications besides cubic and quadratic specifications and mentioned that the empirical findings are at par with this study using the non-linear Gamma and Weibull specifications. They found the turning point within the income range of $15000 to $22000. In their study, Sachs, Panayotou & Peterson (1999) have found a pretty similar result as Schmalensee et al. (1998). The study used panel data of 150 countries, and the ten-segment piece-wise spline function was employed. The turning point of EKC, they have found at income segment of $11500 to $17500.

To test the validity of the Environmental Kuznets curve Stern & Common (2001), in their study, unlike other existing works, considered a global sample of SO_2 emission as a proxy of environmental degradation and income per capita as a proxy of income level and used quadratic specification. They found that with the increase in income, the SO_2 emission

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increased monotonically. Thus, they infer that the emission reduction is time-dependent, not income-dependent, at least for SO_2 emission.

Egli (2001) examined the validity of EKC for Germany using time-series data. In this study for the pollutant NO_x and ammonia, the EKC pattern is found, and the turning point occurred at the income level of 30000 and 33000, respectively.

In their paper, Perman & Stern (2003) also have not found any significant EKC type of relationship among SO_2 emission and per capita GDP for many individual countries. They found cointegration among SO_2 emission and economic growth; however, many countries do not have an EKC-like relationship between emission and economic growth.

Zarzoso et al. (2006) have examined the impact of population growth on the per capita CO_2 emission using panel data from 1975 to 1999 for European Union members. Apart from population growth, GDP per capita, the percentage of the industrial activity concerning the GDP and energy intensity (EI). Log-linear specification of the model is employed. They have found that the impact of population on CO_2 emission for then-new EU members is more than proportional. In contrast, the impact of population on CO_2 emission for then old (existing) EU members is less than proportional.

Akbostancý et al. (2009) have researched two levels to investigate the relationship between environmental quality and income level in Turkey. In their first instance, CO_2emission is used as a proxy for environmental degradation, and the cubic time-series model is employed from 1968 through 2003. Their findings show that the CO_2 emission is a monotonically increasing function of the level of income. In the second model, the panel data is used to test the EKC hypothesis using panel data for the 58 provinces of Turkey for 1992-2001. In this model, the SO_2 and PM_{10} emission is used as a proxy of air pollution. The cubic panel model is also used, and the findings show an N-shaped relationship between income level and environmental degradation.

Jalil & Mahmud (2009) found an EKC relationship between the variable carbon-di-oxide (CO_2) emission and per-capita GDP for China across 1971-2005 using the ARDL approach. Their findings show a cointegration between CO_2 emission and GDP per capita; also, a causality running through economic growth to environmental degradation. The quadratic specification is used to test the validity of the EKC hypothesis. Moreover, a variable for trade openness is incorporated. Their finding is consistent with the empirical finding of EKC.

Ahmed & Long (2012) have tested the validity of EKC for Pakistan from 1971 to 2008. The trade openness variable, energy consumption, and population growth are incorporated as the independent variable in their study. In contrast, CO_2 emission remains the dependent variable. Log-cubic specification of the model is used to test the EKC hypothesis. They found a result consistent with the EKC hypothesis. Also, trade openness is seen to positively impact the environment quality while the population growth contributes toward the degradation of the Environment.

Esteve & Tamarit (2012) have tested the existence of EKC for Spain using extensive time-series data from 1857 to 2007. The study suggests a model with two breaks estimated at 1941 and 1967 and three regimes. The estimated coefficient of per capita GDP suggests that the income elasticity of CO_2 emission over time is declining; in other words, although the per capita CO_2 emission is monotonically rising, the income elasticity is declining. However, the EKC pattern has not been observed for Spain.

The study by Apergis & Ozturk (2014) is based on the panel data of 14 Asian countries, and GMM is used to assess the shape of EKC. Apart from the environmental degradation variable (CO_2 emission) and economic growth variable (GDP), a set of other aspects (such as industrial GDP to total GDP ratio, Population density, area of land and four other factors that reflects the quality of an institution of the nation) also incorporated in this study. The result of this study is consistent with the empirical findings of an inverted-U relationship between Income Growth and environment degradation.

Ozturk & Mulali (2015) incorporated urbanisation, government effectiveness index and control of corruption index, trade openness, GDP per capita and energy consumption as independent variables in their study. The conventional log-quadratic model is used, and the GMM and 2SLS technique of estimation is employed. They found no support for the existence of EKC for Cambodia.

Usama et al. (2015) found a cointegrating relationship among the variables carbon emission, financial development, energy consumption and Economic growth. Using the quadratic specification of the model, they found an EKC type of relationship between the variables CO_2 emission and economic growth.

Hao et al. (2016) have studied the existence of EKC using panel data for 29 Chinese provinces from 1995 to 2012. The variable under consideration is coal consumption (dependent variable) and real GDP per capita (independent variable). Log-cubic specification

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of the model is used. To control for potential spatial dependence in the model, Spatial Durbin Model (SDM) is employed. They found evidence for the inverted-U shape relation between coal consumption and income per capita.

Sirag et al. (2017) examined the validity of EKC for the developing countries using the dynamic panel threshold estimator. The variables under consideration were CO_2 emission (dependent variable) and per capita income (independent variable), and energy consumption (independent variable). They argued that the dynamic panel produces a more realistic income turning point. Their study also gives evidence supporting the EKC type of relationship between income and environmental degradation.

Ota (2017) examined the inverted-U hypothesis and EKC hypothesis for 20 Asian countries. Their study found that both the hypothesis is valid for these countries with some limitations. It is mentioned that the impact of growth on income inequality and environmental deterioration differs substantially among the high-income countries. For low-income nations, the impact of growth on inequality is generally smaller than on environmental degradation.

Ozokcua & Ozdemir (2017) have tested the validity of EKC for 26 high-income OECD countries and 52 emerging countries between 1980 and 2010 using a panel data approach. The estimation technique undertaken is Driscoll-Kraay Standard Errors. Apart from GDP Per capita, energy consumption is also incorporated as an independent variable. The cubic specification for the model is used. For OECD countries, they have found an N shape curve indicating that after following the EKC kind of relationship, environmental degradation started rising with income per capita. The relationship followed an inverse N shape for the other sets of countries (52 emerging countries). These findings are not at par with the empirical results.

Sultan et al. (2021) and Wang et al. (2022) pointed out that renewable energy consumption is an important factor in determining the rate at which economic activity will generate CO2 emissions. Similarly, population density explores the intensity of economic activity and its footprint (Ali et al. 2022).

Data and Variables:

22 African countries, from 1981 to 2021, have been selected randomly and subjected to data availability. Annual data on per capita carbon emission (MT) and per capita GDP (constant 2015 US Dollar) have been used to proxy environmental degradation and economic growth. Apart from these two variables, two more are incorporated viz.

population density and trade openness (total value export and import as a proportion of GDP). Here, environmental degradation is used as a dependent variable. Data of all the variables are collected from the World Bank Databank.

Table 1 : Descriptive Statistics

	GDP per capita (USD constant 2015)	Trade Openness (%)	Population Density	CO2 Emission per capita (MT)
Mean	2252.86	65.89	106.10	1.02
Median	1109.39	57.71	61.41	0.39
Minimum	219.64	9.14	1.64	0.008
Maximum	13612.13	225.02	623.42	9.03
Standard Deviation	2872.69	32.17	131.39	1.67
Observations	902	902	902	902

Source : Calculated by the Author from the collected data

The descriptive statistics of the variables are presented in Table 1. It is seen that the mean of per capita GDP (constant Dollar 2015) is $2252.86 with a standard deviation of 2872.69. On the other hand, the mean population density and per capita CO2 emission are 106.10 and 1.02 MT with a standard deviation of 131.39 and 1.67. The mean trade openness percentage is 65.89, with a standard deviation of 32.17.

ECONOMETRIC MODELS AND SPECIFICATIONS:

A panel data model has been used for the analysis. A panel data set includes a sample of individuals over some time. It is helpful because it allows the researchers to sort out economic effects that cannot be distinguished using either cross-section or the time-series data alone (Pindyck & Rubinfeld, 1998). Other advantages of panel data are (a) Panel data sets usually provide an increased number of data points that generate additional *degrees of freedom*, and (b). Incorporating information relating to cross-section and time-series variables diminishes an omitted variable problem (Pindyck & Rubinfeld, 1998).

The Environment Kuznets hypothesis states that environmental degradation initially increases with economic growth reaching a threshold level and declines with further economic growth. In other words, the economic growth will first deteriorate the environmental quality; then, after achieving a certain level of income level, environmental quality starts to get better with a further rise in the level of income (Grossman and Krueger,

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1991). Most of the existing researchers have been used a cubic function to assess the shape of EKC. The basic model used in many studies is:

$$ED_{it} = \beta_0 + \beta_1 G_{it} + \beta_2 G_{it}^2 + \beta_3 G_{it}^3 + \beta Z_{it} + \alpha_i + \theta_t + U_{it}$$

Here, ED_{it} and G_{it} are the variables used as a proxy for environmental degradation and economic growth in country *i* at time *t*. â is the vector of parameters of all other non-income explanatory variables Z_{it}. $á_i$ is the individual-specific effect, and 5Ø±ß$_t$ is the time-specific factor. U_{it} is the error term.

Based on the values and signs of the coefficients (â's), one can determine the shape and the income corresponding to the turning point of the curve. It can be summarised as:

a. â$_1$>0 and â$_2$=â$_3$=0; here, environmental degradation is an increasing function of economic growth. In other words, with economic growth, the ecological quality will deteriorate monotonically.

b. â$_1$<0 and â$_2$=â$_3$=0; here, environmental degradation is a decreasing function of economic growth. In other words, with economic growth, the environmental quality will get better.

c. â$_1$>0, â$_2$<0 and â$_3$=0; such findings will give an inverted U of the relationship between income growth and environmental degradation. The turning point of this relationship is at an income (G) where $G = \frac{\beta_1}{2\beta_2}$

d. â$_1$<0, â$_2$>0 and â$_3$=0; such findings will shape the relationship between income growth and environmental degradation. In other words, such a relationship suggests that with the increasing growth, the environmental degradation declines reach a minimum and starts rising with further growth. The turning point of this relationship is at an income (G) where $G = \frac{\beta_1}{2\beta_2}$.

e. â$_1$>0, â$_2$<0 and â$_3$>0 imply an N-shaped relationship between income growth and environmental degradation. In other words, with economic growth, environmental degradation increases reach a maximum and start declining after a certain income level. However, this will not continue forever and after, again, reaching a minimum level of degradation, the environmental degradation

again starts rising with the increase in growth. Two turning points (G_1 and G_2) of this relationship are $G_1 = \frac{\beta_2 + \sqrt{\beta_2^2 - 3\beta_1\beta_3}}{3\beta_3}$ and $G_2 = \frac{\beta_2 - \sqrt{\beta_2^2 - 3\beta_1\beta_3}}{3\beta_3}$.

f. $\hat{a}_1<0$, $\hat{a}_2>0$ and $\hat{a}_3<0$ imply an inverted N-shaped relationship between income growth and environmental degradation. In other words, with economic growth, environmental degradation declines to a certain level, reaches a minimum and start to increase after a certain level of income level. However, this increase is also not going to sustain forever, and thus, after reaching a threshold level of degradation, it starts to fall again with increasing income. Two turning points (G_1 and G_2) of this relationship are $G_1 = \frac{-\beta_2 + \sqrt{\beta_2^2 - 3\beta_1\beta_3}}{-3\beta_3}$ and $G_2 = \frac{-\beta_2 - \sqrt{\beta_2^2 - 3\beta_1\beta_3}}{-3\beta_3}$.

g. $\hat{a}_1=0$, $\hat{a}_2=0$ and $\hat{a}_3=0$; suggests no significant relationship between environmental degradation and economic growth.

The relationship between environmental degradation (Per capita CO_2 Emissions) and economic growth (Per capita GDP) has been examined using the following model, incorporating two other explanatory variables, population density and trade openness. All the variables (except Trade Openness) have been transformed in natural logarithm form, and it can be expressed in its standard form as:

$$CO_{it} = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Y_{it}^3 + \beta_4 PD_{it} + \beta_5 TO_{it} + u_{it} \qquad \text{(Model 1)}$$

In Model 1, CO is carbon emission per capita, Y is the GDP per capita (Constant 2015 US Dollar), PD and TO are the population density, Trade openness, and finally, u_{it} is the usual error term. All variables, except the trade openness (TO), are natural log-transformed.

The FGLS (Feasible generalised least square) method has been employed to estimate Model 1. The FGLS has some advantages over panel OLS. The FGLS model considers the serial correlation and cross-sectional correlation in the linear panel model robust to heteroscedasticity, serial and cross-sectional correlation.

Results and Discussion:

Model 1 is estimated both by OLS and FGLS. The OLS estimators suffer from the problems of heteroscedasticity and first-order autocorrelation correlation. The first-order autocorrelation in the OLS model has been tested using the Wooldridge test for autocorrelation, the coefficient of which is significant at 0.01 level, suggesting that the null

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hypothesis of no first-order correlation is not accepted. On the other hand, the Likelihood ratio test has been employed to test heteroscedasticity in the model. The coefficient is significant at a 0.01 level suggesting that the null hypothesis of "no presence of heteroscedasticity" can be rejected. The result of the estimation is given in Table 2.

Table 2. POLS and FGLS estimation

Dependent Variable: Natural Log of Carbon Emission Per Capita [ln (CO)]		
VARIABLES	Methods	
	Panel OLS	FGLS
Intercept	0.35	34.31
(ln GDP)	-4.26	-17.99***
$(\ln GDP)^2$	0.93**	2.49***
$(\ln GDP)^3$	-0.06***	-0.11**
Population Density (ln PD)	0.0085	-0.027
Trade Openness (TO)	0.0039**	0.0025***
Observations	902	
Wooldridge Test statistic (Test of Autocorrelation)	18.56***	---
Likelihood Ratio (Test of Heteroscedasticity)	1684.31***	---
Model type Considered	FGLS	
The shape of the Income-emission relation	Inverse N–shaped relation	
Turning Point – I	---	5.99
Turning Point – II	---	9.01
Note: *** significant at 0.01 level; ** significant at 0.05 level.		

To get rid of these problems, therefore, the FGLS estimation technique has been used. In Table 2, it is seen that the GDP per capita square of GDP per capita variable is significant at the 0.01 level with the coefficients of -17.99 and 2.49, respectively. Also, the cube of the GDP per capita variable is -0.11 and significant at the 0.01 level. This result shows that with the increase in income, the environmental degradation declines to a minimum level and then starts increasing reaches its maximum and starts falling again. It gives an inverseN–shaped relationship between environmental degradation and the level of income. Two turning points in the income-emission relationship are observed. The first turning point is marked at USD 399.41 ($e^{5.99}$) per capita (constant Dollar 2015), and the second turning point is observed at the US $8184.52 ($e^{9.01}$) per capita (constant Dollar 2015).

The trade openness variable is positive and statistically significant at the 0.05 level. The coefficient of trade openness variable, 0.0025, means that a 0.01 increase in trade openness (which is not log-transformed) increases the carbon emission per capita by 0.25%, since $(e^{0.0025}-1) \times 100=0.25$. It signifies that as the economy becomes more open to international trade, it will likely pollute more. This result is at par with the finding of Ozturk & Mulali (2015). On the other hand, the population density variables negative but insignificant at the 0.05 level.

Conclusion:

In this study, the EKC type of relationship has not been observed for the African countries under consideration. The shape of the environmental degradation and income growth is found to be inverse N shaped. Similar findings were found in the studies by Akbostancý et al. (2009), Ozokcua & Ozdemir (2017), et cetera. This finding does not support the existence of the inverted-U (EKC) hypothesis. The two turning points of the income-emission relationship are observed at the US $265.07 and the US $5377.61, which represents that after the per capita income of around USD 265.07, the African countries observe an inverted U pattern of income emission relationship.

On the other hand, an increase in trade openness increases the per capita emission in the African countries. One important reason behind this could be unregulated used car import by African countries. A report by "*Promoting Safer and Cleaner Used Vehicles for Africa 2020 Report" stated that* African nations imported approximately 2.5 million used vehicles in 2017 from the European Union, Japan and the United States. Sub-Saharian African countries have experienced around 75 per cent increase in carbon emission from transportation between 2000-2016. Whereas Nigeria, Ghana and Kenya experienced an increase in transport emission by 16 per cent, 73 per cent and 153 per cent respectively during the same period.

It is very much crucial for the African countries to check the source of increasing per capita income. Copeland and Taylor (1994) stated that the increase in per capita income resulting from trade effects pollution differently than an income increase resulting from economic growth. So, these countries must find avenues or policies other than trade to increase the per capita income. Because the increase in income resultant from trade will dampen the environmental quality. However, policies other than more trade may increase per capita income at the cost of less environmental degradation.

Also, the African nations must adopt policies to restrict the import of used cars,reducing the emission level. Recently, the Automobile Association of Zimbabwe and the other members of the African Council of Touring and Automobile Clubs have appealed to promote safer and cleaner used vehicles in Africa.

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EXTENT OF OCCUPATIONAL DIVERSIFICATION AMONG THE TEA GARDEN LABOUR COMMUNITY OF ASSAM

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Abstract:

This paper is an attempt to study the extent of occupational diversification among the tea garden labour community of Assam. It is done through a sample study of 400 individual workers of tea garden labour community in three districts of Assam viz. Tinsukia, Dibrugarh and Sonitpur done in July 2023. Occupational diversification means adoption of various occupation by individual or households in search of better income, improved standard of living and reduced risk. The study considers almost all probable source of main and alternative occupation of the tea garden labour community viz. tea garden related works, wage earning, construction related works, agriculture and allied activities, animal husbandry, shop keeping, salaried works and other works. The extent of occupational diversification has been calculated by using Simpson Index of Diversification (SID). This index is selected for its wider applicability, robustness and practicality in handing large figures such as rupees. After calculating the index of diversification for each worker, average for all workers in selected districts has been obtained. The data are further compared to all India and all Assam level.

Keywords: Tea garden labour community, occupational diversification, Assam

JEL Code: D31, E24, J01, J21, J24

Introduction:

Occupational diversification means adoption of various occupation by individual or households in search of better income, improved standard of living and reduced risk. It can be viewed in both micro and macro sense. In micro sense, it will mean diversification in the rural farming sector which may be of two different types, namely enterprise

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diversification and crop diversification. It is the farmers' adoption of alternative agriculture related activities along with mainstream agricultural practices as a response towards demand driven or distress driven situation. In the macro sense, it means a change in the contribution of different sectors (viz. Primary, secondary and tertiary) to national income as well as disposition of the working population. This can also be termed as occupational shift (Sawant, 1993) (Boro, 2023). Diversification can be categorised as horizontal diversification and vertical diversification where horizontal will stand for diversification in the same sector (usually agriculture) and vertical will stand for diversification across different sectors (Haque, 1996) (Kumar et. al., 2017). Occupational diversification enables enhancement of income and ensures stability of livelihood. It is one of the major determinants of economic development.

As per Assam Human Development Report 2014, in Assam people residing in '*Char*' areas, tea garden labour community and people belonging to schedule caste are vulnerable section (according to the surveys in spatial diversity blocks). Among various communities, the tea garden labour community is chosen because this category is defined on the basis of their nature of work. According to Assam HDR 2014, this category is socially disadvantaged considering various socio economic factors like income, literacy, land holdings, health, access to basic infrastructure etc. So it is important to find out the status of occupational diversification among the said community.

Data and Methodology:

The study is based on a primary survey conducted through a structured interview schedule in the mid 2023 among the 400 individual workers of different level from the selected tea estates of three districts of Assam namely Tinsukia, Dibrugarh and Sonitpur. The detailed methodology of the study can be discussed with the following sub heads.

Coverage:

i) Universe of the study

The universe of the study is the tea garden labourer community of Assam. In this study, we are considering only the registered large tea estates of Assam as mentioned in the list of Directorate of Tea Tribes Welfare Department, Govt. of Assam. The list comprised of 803 registered tea estates. According to the Directorate of Tea Tribes Welfare, Assam; the garden labour community comprises of approximately 17 percent of the total population of Assam. Assam's population is 3.12 Crores (according to 2011 census data). Therefore,

total population of tea garden labour community is roughly 53 Lakhs across Assam. Latest data is not available as the 2021 census has been postponed. But along with the increase in the general population of Assam in the last decade, population of tea garden labour community is also expected to increase.

Active workers in the tea estates (both permanent and casual) amounts to be 6,76,835. Out of that permanent labourers comprised of 57 per cent and casual labourers comprised of 43 per cent (Office of the Chief Labour Commissioner, Guwahati). However, the updated data given by the State Innovation and Transformation Ayug (SITA), Assam, total tea garden labourers engaged in the large tea estates of Assam amount to be 7.33 lakhs till 2020. It comprises both permanent and casual workers.

ii) Units of observation

Units of observation are individual workers. Sampling is done on household basis and all the working members of the household are included in the study.

iii) Sample Size

While taking the sample size, by taking any of the widely used formula for large number of population like Yamane (1967), Krejcie Morgan (1970) or Cochran (1977) the difference in the numbers will not affect the sample size as these formulas prescribe ideal sample size with the range of 384 to 400 with such large number of samples. Therefore, in this study, Taro Yamane formula is followed and accordingly we are surveying 400 working members of the tea garden labour community.

Data Collection:

i) Types of Data and Data Source

Both primary and secondary data are used in the study. The primary data are collected through a structured interview schedule in the selected tea estates of the purposively selected districts of Assam.

Secondary data are taken from different sources like Government of India Census, Central Statistical Organisation (CSO), Different Rounds of relevant National Statistical Survey Organisation (NSSO) data, Assam Human Development Report, Govt. of Assam Official Website, Statistical Handbook of Assam, and Assam Economic Survey etc.

ii) Sampling Design and Sampling Methods

Although tea gardens and tea garden labour community are found in both Brahmaputra and Barak valley; but tea gardens and the said community is mostly residing

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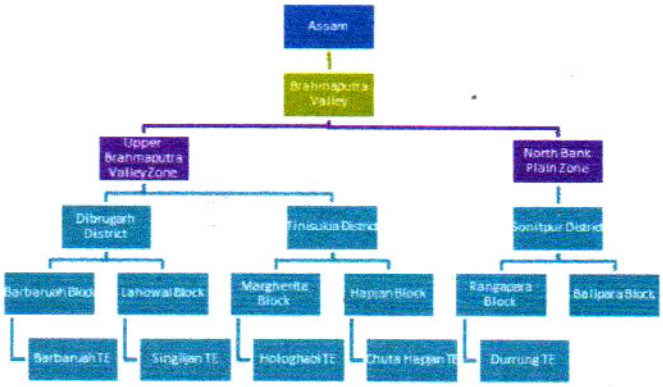
in the Brahmaputra valley, as per the office of the labour commissioner, Guwahati. Entire Brahmaputra valley accounts for 87.8% of the tea estates in Assam. Therefore the study is confined in the Brahmaputra valley itself.

Out of six agro climatic zones of Assam, Brahmaputra valley has 4 zones viz. upper Brahmaputra valley zone, lower Brahmaputra valley zone, north bank plains zone, and central Brahmaputra valley zone. Out of these zones, tea gardens are mostly confined in upper Brahmaputra valley zone and north bank plains zone (Assam HDR Survey, 2013). Therefore, the primary survey is done purposively in these two zones.

Moreover, out of the 803 total tea estates of Assam (Directorate of Tea Tribes and Welfare), 70 percent are located in upper Brahmaputra valley zone, as per the Office of the Chief Labour Commissioner, Guwahati. According to Assam Government classification, upper Brahmaputra valley zone comprises Tinsukia, Dibrugarh, Sibsagar, Jorhat, Golaghat District. North bank plains zone comprises Darrang, Sonitpur, Lakhimpur and Dhemaji districts.

In order to collect the data from households multi-stage sampling procedure has been followed where the districts are chosen first then the blocks and it goes on as shown in the flow chart below-



In the study two districts are selected from the upper Brahmaputra valley zone and one district will be selected from north bank plains zone. District selection is done purposively based on the proportionate share of tea gardens of the selected district to that of the total of entire Brahmaputra valley. Two development blocks from each selected district are selected randomly. Furthermore, one tea garden is selected randomly from

each selected block and households are also selected randomly. All the working members of the household have been considered for the study.

As the ex-tea tribes are hidden in a huge population universe, it is purely a matter of chance in the random sampling to find such sample. In the study, a good number of workers are available who do not have direct relationship with the tea garden labour activity and are engaged in other works like daily wage-earning activity, construction related activity, agriculture and allied activity etc. As the government of Assam has wiped out the sub division as tea tribe and ex tea tribe, no separate provision of sampling is made for the ex-tea tribes under the study (Assam Government order no. TTWD.49/2017/3 dated 02/02/2019).

Line of Analysis:

The objective of the study is to determine the extent of occupational diversification among the tea garden labour community of Assam. It has been fulfilled by taking individual income data and share of different economic activities to that of total income of the workers. Then individual incomes are summed up to get the aggregate income. From the individual share of different economic activities, aggregate proportion of different activities with respect to total income is calculated. Finally, Simpson's Index of Diversification (SID) is used to get the extent of diversification. The formula of calculating Simpson Index of Diversification (SID) is

$$\text{SID} = 1 - \sum_{i=1}^{n} P_i^2$$

Where, Pi=Proportionate value of i^{th} activity in the total value of economic activity The index ranges from 0 to 1 where 0 means complete specialisation and 1 means complete diversification.

Although there are various index to determine diversification in various aspects like Simpson Index (SI), Herfindahl Index (HI), Entropy Index (EI), Modified Entropy Index (MEI) etc. the rationality of choosing Simpson Index of Diversification (SID) is that,

i) Through this index, extent of diversification can be interpreted directly which is not possible through indices like Herfindahl and Entropy Index.

ii) Although Transformed Herfindahl Index (THI) measures diversification directly; but SID is relatively superior because in terms of value, SID is considered as one of the best indices to handle with the big figures like in

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lakhs and crores of rupees. This will be significant in the proposed study because income level of the individual and households will place a crucial part in studying diversification.

iii) Moreover, SID is simple and convenient to calculate and use. it is also a robust measure and has wider applicability in quantification of the intensity of diversification.

It is for this reason, different studies (Khatun and Ray, 2012, Mandal and Bezbaruah, 2013, Saha and Bahal, 2014, Saikia and Goswami 2015, Dutta and Saikia, 2016, Khan Et. al. 2017, Swargiari (2020) etc.) have used Simpson index of diversification in their respective research work. So, this index has been found most appropriate in this study too. Hence SID index has been used in this study to know the occupational diversification among the tea garden labour community of Assam.

Results and Discussion:

With the help of Simpson Index of Diversification (SID), diversification index of each worker is obtained. It ranges between 0 and 1. It can be averaged in terms of districts or in terms of total workers across Assam to get the overall picture of extent of diversification among the tea garden labour community of Assam. At first, we can look into the occupational diversification in terms of Simpson index in the surveyed districts as follows.

Table 1: Occupational diversification among the tea garden labour community in the sample districts

District	Diversification Index (Average SID)
Sonitpur	0.42
Tinsukia	0.32
Dibrugarh	0.32
All Assam (All sampled district)	0.34

Source: Sample Survey

From the above table, it is clear that in all the surveyed districts, occupational diversification in terms of SID is almost similar. However, Sonitpur district is a bit above the list with SID index of 0.42. Dibrugarh and Tinsukia districts are found at par with SID index of 0.32. All Assam average SID calculated from the surveyed tea gardens is 0.34. Now we can compare the above index with the index of Assam and all India along with other major states. For this we can refer to a study done by Khan et al. (2017). In this

study, the livelihood diversification of farm households of Uttar Pradesh has been studied. The authors have used NSSO 70th Round of data to find out the various income earning activities undertaken by the farm households of major states of India. From these data, they have calculated the Simpson Index of Diversification for all the concerned states and for all India level. This table is helpful in drawing the comparative picture of the diversification status among the tea garden labour community of Assam to the rest of the state and all India average. For this, the table of that study has been placed here.

Table 2: SID index of India and its major states

	Income sources of households						
State	**Cultivation**	**Livestock**	**Other agricultural activity**	**Non agricultural enterprises**	**Wage/salaried employment**	**Others**	**SID**
Andhra Pradesh	592	46	16	35	280	31	0.57
Assam	767	42	16	23	128	24	0.39
Bihar	697	30	2	50	163	58	0.48
Chhattisgarh	805	0	6	15	168	7	0.32
Gujarat	584	90	7	37	267	14	0.58
Haryana	600	91	0	47	236	26	0.57
Jharkhand	725	1	8	46	186	35	0.44
Karnataka	694	40	31	24	193	17	0.48
Kerala	161	60	169	134	299	176	0.80
Madhya Pradesh	753	25	1	6	204	11	0.39
Maharashtra	717	27	5	49	180	22	0.45
Odisha	602	10	12	73	259	43	0.56
Punjab	456	92	8	51	319	74	0.67
Rajasthan	456	64	8	55	334	82	0.67
Tamil Nadu	548	102	11	23	293	23	0.60
Uttar Pradesh	652	31	2	51	187	76	0.53
West Bengal	558	12	17	83	268	63	0.61
All India	635	37	11	47	220	51	0.54

Source: Calculations based on NSSO 70th round data (Khan Et. al. 2017)

It is clear from the above table that occupational diversification index among the tea garden labour community of Assam (0.34) is almost similar to that of the occupational diversification status in general in Assam (0.39). But if we look at the all-India average, it is higher at 0.54. In a similar study of livelihood diversification among the Bodo community of Assam, Swargiary (2020) finds that livelihood diversification among the Bodos is 0.42

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in terms of SID. His study is based on the sample survey of BTAD areas of Assam comprising of Baksa, Chirang, Kokrajhar and Udalguri. The tabular form of the extent of diversification in that study can be displayed as under.

Table 3: Extend of livelihood diversification in four districts of BTAD, Assam

District	SID value
Baksa	0.38
Chirang	0.39
Kokrajhar	0.40
Udalguri	0.48
Overall	0.42

Source: Swargiary (2020)

Although the two communities (Bodo and tea garden labour community) are completely different in nature of work and socio economic and demographic profile, yet, to get an overall comparison of two different communities of the same state i. e. Assam we can take a look at the SID of both the communities. So, if we compare the livelihood diversification among the Bodos and that of tea garden labour community we find that the Bodo community is marginally more diversified than the tea garden labour community. The comparative picture can be shown with the following table.

Table 4: Comparative status of Bodos and Tea Garden Labour Community in terms of extent of diversification

Community	Average SID (All Assam)
Bodos (Assam)	0.42
Tea Garden Labour Community (Assam)	0.34

Source: Swargiary (2020) and field survey

Gender wise analysis of occupational diversification among the tea garden labour community of Assam:

It is important to know the gender wise details of the sampled households and workers. In this study, no purposive sampling is adopted gender wise while taking the response of workers among the tea garden labour community. In the sample survey, the number of male female worker can be stated as below:

Table 5: Percentage of male female workers in the sample survey

District	Male workers	Female workers	Total
Sonitpur	48.5	51.5	100.0
Tinsukia	62.5	37.5	100.0
Dibrugarh	59.1	40.9	100.0
Total (All Assam)	58.5	41.5	100.0

Source: Sample Survey

Here male and female workers selection is not purposive and merely a matter of chance, i.e. random selection. But in the tea estates, it is noticed that, female participation is almost at par with men and sometimes it exceeds male counterparts. It is supported by some other studies also. For example, Devi (2022) aptly mentions that in Assam, more than 50% women workers are engaged in the tea industry as a whole. However, it is to be noted that, in this study, workers belonging to tea garden labour community is taken into consideration. Some of them are found to be out from tea garden related work. Either their other family members are working in the tea estates and they are engaged in some other income earning activities or the whole family is completely out of the tea garden related activity. In the latter case, the family will be considered as 'ex tea tribe' as defined by the Tea Tribes Welfare Department, Govt. of Assam (ttwd.assam.govt.in). In the study, selection of ex tea tribe is also not purposive and is a matter of chance.

Now we can show the extent of occupational diversification among the male and female counterpart of tea garden labour community which is calculated through SID.

Table 6: Gender wise status of occupational diversification

District	Diversification Index (Average SID)	Average SID (Male)	Average SID (Female)
Sonitpur	0.42	0.41	0.43
Tinsukia	0.32	0.32	0.32
Dibrugarh	0.32	0.33	0.30
Total (All Assam)	0.34	0.34	0.33

Source: Field Survey

From the table 6, it is clear that the averages SID of male and female tea garden labour community workers in the respective districts are approximately closer in value. It is because the work participation is almost equal across gender in the tea garden areas

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(Devi, 2022). We can notice that except Sonitpur district, where diversification is found to be marginally high among the female workers compared to the male counterparts. It is because, in the field survey, it was noticed that many women workers are engaged in extra income earning activities like animal husbandry etc. which increase the diversification index. Otherwise, in other surveyed districts and all Assam average, the indexes are almost similar.

Status of diversification by nature of works:

In tea garden areas, the main occupation is undoubtedly the tea garden works. Such workers are divided into two distinct groups-permanent and casual workers. Permanent workers are engaged in the tea garden activities round the year. On the other hand, casual workers are hired only in the busy plucking seasons. It ranges from minimum 3 to maximum 9 months. On an average, they are engaged in the tea garden related activities for 6 months only. So in the slack seasons, they work in some other activities to stabilize their income and sustain their livelihood. Such works may be wage earning activities, construction works, shop keeping, agriculture and allied activities, animal husbandry etc. It is not that the permanent workers don't diversify. They have also diversified in search of better income or to support their family. But, as they cannot devote too much time in other activities, so the opportunity to diversify is less. It will be clear from the following table.

Table 7: Aggregate SID in respect of nature of work among the tea garden labour community of Assam

District	Average SID of Permanent Workers	Average SID of Casual Workers
Sonitpur	0.17	0.48
Tinsukia	0.10	0.46
Dibrugarh	0.16	0.43
Total (All Assam)	0.14	0.45

Source: Field Survey

This table clearly shows that occupational diversification among the casual workers are way higher than that of the permanent workers. Approximately 43 percent of the total workforces in the tea gardens are casual in nature (Office of the Chief Labour Commissioner, Guwahati). So, it can be stated that these labourers are diversifying significantly across Assam. Presence of high number of casual workers in the tea estates of Assam is a clear indication that occupational diversification is also high among the tea garden labour community of Assam on an average.

Categorization of diversification among the surveyed workers:

As the survey gives individual diversification index of all the workers taken in the sample survey, it is important to classify the workers according to their intensity of diversification. In the review of literature, it is found that some researchers have categorized the intensity or extent of diversification into three categories as low, medium and high. We can cite the study of Saha and Bahal, 2014; Kumar and Srivastava, 2017 for such classification. But Swargiari (2020) in his study of livelihood diversification among the Bodo communities of Assam has classified the intensity of diversification into six distinct phases taking the help of mean diversification index and standard deviation. As such categorization gives more detailed insights into the intensity of diversification; this study is also following the same pattern. The categories are

i) Not diversified
ii) Least diversified
iii) Less diversified
iv) Moderately diversified
v) Highly diversified
vi) Fully diversified

Here the minimum value of SID i.e. o (zero) will represent absence of any diversification and maximum value of SID i.e. 1 (one) will represent full diversification. To find out the categories in between the extreme end, mean value of SID ($\overline{X}$) and standard deviation (σ) will be used. The mean value of SID will be the average diversification index which is 0.34 for the sampled districts in total. Standard deviation is calculated as 0.23. Now the classification will be done as

i) Not diversified (SID value 0)
ii) Least diversified ($\overline{x} - \sigma$ to >0) (0.11 to >0)
iii) Less diversified ($\overline{x}$ to $\overline{x} - \sigma$) (0.33 to 0.12)
iv) Moderately diversified ($\overline{x}$ to $\overline{x} + \sigma$) (0.34 to 0.56)
v) Highly diversified ($\overline{x} + \sigma$ to <1) (0.57 to <1)
vi) Fully diversified (=1)

Now we can calculate the absolute numbers and percentage of working members of the tea garden labour community from the sample. It is represented in the table below:

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Table 8: Status of Livelihood Diversification of the Sample Households

Basic of classification	Index Value	Status of diversification	No. of households	Percentage
Minimum Value	0	Not diversified	90	22.5
$\bar{x}$- σ to >0	0.11 to >0	Least diversified	3	0.75
$\bar{x}$ to $\bar{x}$-σ	0.33 to 0.12	Less diversified	91	22.75
$\bar{x}$ to $\bar{x}$+σ	0.34 to 0.56	Moderately diversified	143	35.75
$\bar{x}$+σ to <1	0.57 to <1	Highly diversified	73	18.25
Maximum Value	1	Fully diversified	0	0
Total			400	100

$\bar{x}$ =0.34, σ=0.23

Source: Sample Survey

The table shows that among the sampled workers, 22.5 percent of the workers are not diversified and they pursue only one occupation. They are absolutely concentrated in their economic activities. The reason for absolute concentration are found as

i) Permanent workers found less time, scope and opportunity to diversify

ii) A few workers are in some more gainful work away from tea garden low paying activities. Their income is sufficient to meet their own and family needs.

On the contrary, 18.25 per cent workers are found to be highly diversified. Major portion of the surveyed workers are found to be moderately diversified (35.75 per cent). The main reason of high and moderate diversification are found as

i) Casualization of tea garden related work which provides employment for roughly 6 months a year only.

ii) Moreover, the tea garden related works are less remunerative in nature. For instance, in the Brahmaputra valley the wage rate for tea garden labour is 250 rupees per day per head and that of Barak valley is even lower at 228 rupees as revised by the government of Assam after slight increase as of October 2023 (The Economic Times 02.10.2023). So to support the family and own day to day needs, the worker is bound to go for diversification.

iii) So most of the diversification activities in this field are distress led diversification in nature.

Among the total number of 400 working individuals, 91 individuals i. e. 22.75 per cent are less diversified and a very small amount of workers i. e. only 3 workers (0.75 per cent) are least diversified according to the categorization. In the sample survey, no workers are fully diversified at the value of SID=1.

Mean Source of Income and Mean Amount of Income per Category:

Now we can examine the average source of income source adopted by workers per category of diversification level. Here, first there will be the 90 numbers of workers whose diversification index is 0. They are absolutely concentrated with only 1 source of income. The number of income source increases with the increase in the diversification index value. In this part, the details are analysed with mean sources of income and mean amount per category which is categorized above. Mean no. of income source is calculated by dividing the total number of income source of one category by the total number of workers in that category.

Table 9: Mean Source of Income and Mean Amount of Income per Category of Diversification

Category of Diversification	No. of Workers	Percentage	Mean No. of Income Sources	Mean Income per Year (in Rs.)
Not diversified	90	22.5	1	95411
Least diversified	3	0.75	2.33	216000
Less diversified	91	22.75	2.11	91284
Moderately diversified	143	35.75	2.36	92455
Highly diversified	73	18.25	3.26	107751
Fully diversified	0	0	0	0
Total	400	100	2.16	96572

Source: Sample Survey

The above table reveals that the mean number of income sources among the surveyed workers of tea garden labour community of Assam is highest in highly diversified category (3.26). It is very much expected as the extent of diversification already indicates that. It is followed by moderately diversified (2.36), least diversified (2.33) and less diversified (2.11) respectively. However, apart from the highly diversified category, the mean sources of income in the other categories are almost same. Mean source of income in the undiversified or absolutely concentrated category is obviously 1, as they are dependent on only 1 source of income for their livelihood.

After examining the mean source of income of the various categories of diversified workers we may be interested to know if there is any difference in the mean annual income of the selected category of diversified/undiversified workers. Here comes an important question, do the mean income of the workers increases category wise as they

move from absolutely concentrated to highly diversified category. Which category workers earn more, highest or lowest on an average? Answers of these questions can be given with the help of the same table. Coming to the mean income of the workers under different category, highest income is there in the least diversified category (216000 rupees per year). In this category diversification index ranges from 0 to 0.11 only. However, in the randomly selected sample, only 3 workers fall in this category. It is followed by the highly diversified category with mean income of 107751 rupees per year. The average annual income per year is found to be lowest in case of less diversified category (91284 rupees per annum). In case of absolutely concentrated category, the average annual income is 95411 rupees per annum. Overall, barring the least diversified category, mean or average income of all the sampled workers are found to be in and around 1 lakh rupees per year. In total, the mean annual income of all the 400 sampled workers are found to be 96572 which is low compared to the per capita income of Assam and India. The sample survey was done in the year 2023. According to the estimates of Directorate of Economics and Statistics as per the advance estimates, the per capita income of Assam at current prices for the FY 2022-23 is estimated to be attained at Rs. 118504 (Ministry of Statistics & Programme Implementation, 2023).

Summary and Conclusion:

The tea sector in India and particularly in Assam had experienced a crisis since early 1990s till year 2001. It is in the form of reduced production, export and closure of tea gardens (Misra, Upadhyay & Sarma, 2012). In 2001 itself, 36 tea estates across various tea producing states are closed and abandoned affecting the production, export and employment of thousands of labourers. However, the situation got normalized and showed some signs of revival after 2002. Some tea estates are reopened again and production also increased gradually (Rai R. 2022). But it is important to know the status of workers after the crisis. Hence, it is very crucial to study the status of occupational diversification among the tea garden labour community of Assam, as the major tea producing and exporting state across India in the recent time. This study is a mild effort in this regard. The study found the extent of occupational diversification of the tea garden labour community across selected districts of Assam and their comparison with state and national average. It also throws light on the possible reason and justification of different levels of diversification among the community.

Policy Implications:

1. As extent of diversification is way higher in case of casual workers, tea garden management authority should help the casual workers in adopting better diversification mix. Because these workers get employment from the tea garden only for six months on an average. So diversification becomes a compulsion for them.
2. To encourage the diversification in the construction sector as semi-skilled and skilled worker; government can encourage the workers with proper micro level training. It cannot be expected from the tea garden management authorities as that will be outside their purview.
3. As the wages of the mainstream tea garden works are very low and it is not sufficient to satisfy the increasing demand of livelihood, the garden authority can itself encourage the workers to indulge in some small domestic income earning activities like animal husbandry, vegetable gardening for commercial purpose etc.
4. In the sample survey, it is noticed that the access to loan or credit facility is very limited among the tea garden labour community. So the state government and other financial institution can come forward to offer loan especially to the casual workers and those who have completely left the tea garden related jobs in search of other job opportunities. It can help the people to start of petty business like shop keeping and some self-employment opportunities.

Declaration of Interest:

The authors have no conflict of interest.

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DETERMINANTS OF MALNUTRITION OF CHILDREN IN ASSAM

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Abstract:

Malnutrition can be considered as condition of formative debilitation of children as it hinders the child's endurance and development. It also increases the prevalence of ailment and mortality among the children. Malnutrition transmitted from generation to generation has grave consequences on the well-being of the children that has seriously affected the capabilities of them to perform in a best possible way. It may further impede reduction of poverty and economic growth, in particular. The prime goal of the present study is to find out the determinants of Malnutrition of children in Assam by applying logistic regression model. The study has found that the variables like age of children, birth interval, food score, Mother's nutritional status, wealth status, statistically significant association with the nutritional status of children.

Key word: Malnutrition, socio-economic condition, mother's education.

JEL Codes: I12, I15, J13

Introduction:

Nutrition and health are predominant needs of the life through which development goals can be achieved effectively by a nation. Good nutrition of the children has positive role in developmental path through reducing health expenditure and in turn increasing productivity of the economy (Hoddinott et. al 2008). But it is a worldwide concerned that malnutrition is a devastating socio-economic problem for world economy. For many developing countries, malnutrition is major challenge to be dealt with without much delay. Malnutrition debarred the overall development of the child and increases the chance of

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morbidity and mortality. The generational transmission of it harms the developmental process (Haddad 2015).

One major form of malnutrition is stunting. The children whose height for age is less than minus 2 standard deviations from the median height for age of reference child population of WHO standard are considered as stunting. Choronic undernutrition at the pregnancy or infants or even in childhood is the root cause of stunted growth that retards the potential development of children (Black R.E.et.al 2013). Stunting debars cognitive development and schooling performance and ultimately restricts the overall development of a child. About 149 million children below 5 years i.e. 22 per cent of global children of age under five years in 2020 are stunted which is alarmingly high (UNICEF, WHO, World Bank 2021). Fifty per cent of the world malnourished children are belonging from three Asian countries India, Bangladesh and Pakistan (Hodinoot 2016). Being a developing country India has been suffering from acute malnutrition problem of children below six years. Assam, a state of India has also higher prevalence of stunting. About 35 per cent of total children of age under 5 years are stunting in Assam which is just lower than national rate of stunting 36 per cent (NFHS 5 India). Therefore elimination of malnutrition in all forms of under six children is prime goal of India as well as for the State.

Statement of the Problem:

India as well as Assam is far away from achieving the Millennium Development Goal with respect to eradicate malnutrition in India. Although India has implemented direct nutritional scheme Integrated Child Development Services (ICDS), POSHAN Abhiyaan expecting to reduce malnutrition level in the country, yet the Country as well as Assam has been facing major challenges to eradicate the problem of malnutrition. Under these circumstances, it is highly essential to identify the responsible socio-economic factors for the existence of malnutrition. Different studies have found various socio-economic factors of malnutrition. In India, multiple factors such as mother's education, caste, gender of household, residence, poverty, type of house, birth order of children, socio economic status and food insecurity are found to be responsible for malnutrition (Singh, 2020). Inefficiency in feeding practices and hygiene practices are found as common phenomena among illiterate mother which may cause of higher prevalence of undernutrition among their children (Adhikari et al., 2017). The children of mothers with low BMI are more prone to undernourished (Ntenda et al., 2018). The children of higher socio-economic status are less likely tostunting

than the children of lower socio-economic household in Lahore (Mushtaq et al., 2001). The various national surveys have simply identified the socio-economic factors, but have no rigorous study about the factors with sophisticated statistical tools.The infant and under five mortality rates are high among the children whose mothers' age at first birth is less than 20 years (NFHS-4 India, Assam). From India's perspective, around 41 per cent underweight is noticed who born at the interval of less than 2 years which is 28 per cent among the children born after the gap of 5 years or more (Chungkham et al., 2020).Comparatively,the children of tribal community are more prone to stunting (43.8 per cent) than the other communities in India (NFHS4, India).More than 40 per centchildren with uneducated mothers are stunting in India (46.3 per cent) as well as Assam (42.1 per cent) while 25.7 per cent of children and 27.1 per cent of children are stunting among the children of higher educated mothers in India and Assam respectively (NFHS 5, India and Assam).

Further, the total population of Assam is 312.06 lakhs among which 46.38 lakhs are below 6 years children which consists of 14.86 per cent of total population of Assam (2011 census).The socio-economic indicators portray the panic picture of Assam. The percentage of population below poverty line is remarkably high in Assam i.e. 31.98 per cent which is higher than India's rate 21.92 per cent (2011 census). Around 30 per cent of population has under Multidimensional Poverty Index (MPI) as the population is deprived of at least four indicators out of 10 indicators. The higher pressure of poverty is due to lack of adequate house quality, improved cooking fuel and sanitation and lower rate of at least six years of schooling (HDR, Assam -2014). The HDI value is .557 in Assam (Assam HDR 2014) that indicates medium category states.Under these circumstances, the present study is an attempt to examine the present nutritional status of children and to identify the determinants of malnutrition in Assam.

Conceptual Framework of nutrition:

UNICEF identified the various determinants of undernutrition of child for the first time by framing the “UNICEF’s conceptual framework of malnutrition of child” (UNICEF1990). The conceptual framework represents the theoretical aspects of malnutrition which depicts the causal and logical association of different factors.

According to the conceptual framework the immediate causes of child malnutrition are burden of ailment and improper dietary intake. Due to improper dietary intake a child becomes more susceptible to disease, which in turn reduces the appetite

and digesting capacity of nutrient foods and ultimately suffers from undernutrition. The underlying determinants are households' food security, proper care of children and women and adequate accessing basic health services and hygienic environment. Due to improper dietary intake, accessing health and child care services and unhygienic environment the child has to suffer from illness which puts the child into malnutrition trap. There are some basic determinants which impact on nutritional status of children through the underlying causes or determinants. These are the level of parents' education, employment status, availability of qualitative resources, income level and technological advancement. These basic determinants are dependent on some other basic factors such as physical and financial capital, human capital, social capital that ultimately depend on socio-economic, political and cultural environment of the economy (UNICEF 2015).

Hence, multiple factors are associated with the problem of malnutrition according to conceptual framework.

Review of Literature:

Previous studies have found some responsible socio-economic factors that impact on malnutrition problem of children. The following literatures have shown these aspects.

The child stunting generally starts within first 1000 days of life. The factors like food intake, maternal health status, micronutrient shortages, environment, suffering from diseases and socio-economic condition are the strong determinants of health and nutrition (Black et.al 2013,Ikeda et.al 2013). The study in Bangladesh shows that mother's BMI, parent's education, child age and sex, settlement of residence, socio-economic status, food security, religion and community status are the significant factors that affect on nutritional status of children (Chowdhury et.al 2016).

In India, the immediate causes of malnutrition are insufficient food intake and infectious diseases (Gragnolati et.al 2005). The underlying causes of unhygienic sanitation including open defecation which leads to different forms of infections, lower range of coverage of health facilities, inefficiency in administration, less political will and commitment, unenthusiastic implementation of health and nutritional related programs and policies, inadequate economic growth, inequalities in distribution of income and women's status (Black et.al 2008, Victoria et.al 2008). Apart from poor economic condition illiteracy aggravates the problems. Most of uneducated people are not concerned about their nutrition, health, proper breastfeeding, dietary intake, environment etc. Without awareness the nutritional programme cannot be succeeded (Singh. A, 2020).

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Data and Methodology:

Both primary and secondary sources of data are used for the study. However, primary data collected through structured questionnaire are used for the analysis. The multi stage sampling is tocollect primary data. For the study, based on the calculated health index, sample districts are selected. The Principal Component Analysis is used to construct the health index and for which NFHS4 data are used on the selected parameters such as percentage of underweight, stunting and wasting children; percentage of children suffering from Acute Respiratory Infection and diarrhea. Based on the constructed child health index values and geographical location six districts are selected as sample districts.

Table 1: Districtwise Health status of Assam

Disrict	Underweight	Stunting	Wasted	Diarrhoea	ARI	Health Index value	Rank of good health
Jorhat	18.1	25.5	14.8	1.7	0.7	2.98E-07	1
Nalbari	20	26.8	15.3	1.3	0	0.030067	2
Dhemaji	**15.8**	**35.5**	**6.2**	**4.1**	**1.5**	**0.106461**	**3**
Lakhimpur	**24.4**	**29.3**	**11.2**	**1**	**0.8**	**0.121849**	**4**
Golaghat	20.2	32.6	13.9	1	0.6	0.138675	5
Kamrup metro	23.2	24.6	11	6.8	0.3	0.142408	6
Dima-Hasao	18.2	34.7	6.3	2.6	2.7	0.147705	7
Baksa	22.4	32.4	10.5	2.7	1.3	0.19768	8
Karbi-Ang	23.7	28.1	18.7	0.8	1.6	0.232885	9
Sivsagar	22.2	35.5	8.3	4.7	1.1	0.263757	10
Kokrajhar	27.1	30.6	15.7	0.9	1.8	0.309214	11
Chirang	24.7	40.1	13	0.8	0	0.324476	12
Sonitpur	**26.9**	**28.7**	**21.5**	**2.4**	**0.5**	**0.349389**	**13**
Kamrup rural	29.6	33.3	18.8	4.5	0.9	0.519463	14
Nagaon	**31.3**	**38.4**	**13.3**	**3**	**1**	**0.525048**	**15**
Hilakandi	32.5	38.1	19.1	0.7	0	0.532156	16
Udalguri	31.8	39.1	18.3	0.6	0.3	0.534469	17
Dibrugarh	33	33.3	22.4	1.3	0.7	0.547981	18
Morigaon	26.8	38.4	10.3	6.5	3.4	0.583095	19
Barpeta	33.1	41.7	16.6	1.8	1	0.643202	20
Bongaigaon	32.9	39.1	23.6	1.4	0.5	0.670511	21
Tinsukia	32.7	36	14.8	5.5	2.8	0.6718	22
Karimganj	35.6	42.3	17.6	3.6	0	0.726849	23
Darrang	37.9	43.5	19.2	0.7	0.5	0.761762	24
Goalpara	**39.5**	**42.7**	**22.1**	**2.7**	**1.5**	**0.919039**	**25**
Dhubri	**39**	**47.4**	**22.2**	**2.7**	**0.4**	**0.955645**	**26**
Cachar	36.3	36.3	30.6	6.7	2	1	27

Source: NFHS4 Assam, India

The districts are sub-divided equally into two groups on the basis of index values. The districts having values below .5 are grouped as better health status districts and the districts with values above .5 are grouped as poor health status districts. Accordingly Dhemaji, Lakhimpur and Sonitpur districts are taken randomly from better child health status group while Nagaon, Goalpara, and Dhubri districts are taken from poor child health group of Districts. Geographically, two districts Dhemaji and Lakhimpur are selected from Upper Assam, Sonitpur and Nagaon are from Middle Assam and Goalpara and Dhubri are from Lower Assam as the sample districts for the study.

In second stage, one development block from rural area and one municipal board/ town committee from urban area are selected from each sample district on the basis of consisting highest rate of children of age 0 to 6 years as reported by census 2011. In third stage, one Gram Panchayat from each selected block and one urban ward from each selected municipal board/town committee are selected following same criteria as in selection of blocks and town. In fourth stage, 5 villages are selected from each sample Gram Panchayats purposively. In fifth stage, the households are selected purposively from the sample villages and wards purposively. The households having children under six years of age are selected from each sample villages in accordance to sample designed formula[1] total 1415 households are selected which consists of 1800 children of age under 6 years. Among them 720 households from rural and 695 households from urban areas are selected.

The following table 2 depicts the mean and standard deviation of different variables like underweight, stunting, wasted, diarrhea and ARI used in PCA. The values that are putted in PCArepresent the percentage of prevalence of said deficient of child health in different districts.

Table 2: Statistical outcomes of PCA

Variables	Minimum	Maximum	Mean	Std. deviation
Underweight	15.8	39.5	28.1	6.86
Stunting	24.6	47.4	35.3	5.88
Wasted	6.2	30.6	16.1	5.7
Diarrhea	.600	6.8	2.68	1.97
ARI	.00	3.4	1.03	.897

1. The sample size is determined using the formula $n = \frac{Z^2.N.\delta_\rho^2}{(n-1)e^2 + Z^2.\delta_\rho^2}$ where Z is the standard variate, ∂ = standard deviation, e = error, N= population size of the area, Z=1.96 at 95 per cent confidence level

From the above table 2, it is observed that in an average around 28.1 per cent of children are suffered from underweight, 35.3 per cent is stunting, 16.1 per cent children is wasted. Around 2.68 per cent children is suffered from Diarrhea and 1.03 per cent children is endured from ARI in Assam. The standard deviation is high in case of underweight.

Methodology:

To fulfill the objective, the nutritional status is evaluated in terms of stunting. Stunting is assessed on the basis of height for age (HAZ) (WHO 2006). The prime objective of the study is to find out the determinants of child undernutrition. Therefore, to identify the factors influencing the status of child nutrition a binary logistic regression analysis is operated. One of the independent variables is socio-economic status of household which is represented by the constructed wealth index. The wealth index is constructed by applying PCA considering the variables like consumer durables including radio, TV, computer, phone, refrigerator, bicycle, motorcycle, car; second, the household's quality represented by type of house such as pucca, cutcha etc. separate kitchen; third, the household's amenities including cooking fuel like LPG, firewood; source of energy such as electricity, kerosene; drinking water and sanitation facilities and fourth, the size of land holding in terms of bigha. The similar variables and methodology are used by IIPS and Macro International, 2007, National Family Health Survey (NFHS 4) India and Planning Commission of India.

Results and Discussion:

Demographic and Socio-economic Status:

Demographic composition depicts the share of population regarding the different age groups, sex ratio and dependency ratio which impact on the economic development of an economy. The table 3 represents the Demographic Composition found in the present field survey.The population is considered from 1415 sample households.

Table 3: Demographic Composition

Group	A	B	C= (A+B)	D	E= (C+D)	F	G	H	I
Age Composition	0-3 yrs	3-6 yrs	0-6 yrs	6-14 yrs	0-14 yrs	15-59	15-64	64 above	Total
Male	232	668	900	397	1297	1564	1586	82	2965
Female	254	646	900	542	1442	1586	1636	120	3198
Total	486	1314	1800	939	2739	3150	3222	202	6163
% of total population	7.8	21.3	29.2	15.2	44.4	51.1	52.2	3.2	100

Source: Field Survey

It appears from table 3 that the children of 0 to 6 years are 29.2 per centof total population which is remarkably higher than the Assam (14.8 per cent) and national level (13.1 per cent) (Census 2011). The percentage of working age population (15-59 years) is 51.1 per cent which is again lower than the rate of Assam (60.4 per cent) and national level (60.7 per cent) (Census 2011). A large part of total population i.e. about 44.4 per cent of total population is children of age 0 to 14 years.The dependency ratio is 58.75 in Assam and 59.4 in India as per estimation of census 2011 and which is estimated at 91.2 for the present study. The higher dependency rate indicates the economic pressure of the economy.

On the other hand, the socio-economic status is examined by constructing wealth index. The table 4 represents the wealth status among the sample households.

Table 4: Wealth Status among the Sample Households

Wealth Status	Number of Households	Percentage of Households
High wealth Index	55	3.9
Medium wealth Index	50	3.5
Low wealth Index	1310	92.6

Source: Field Survey

It appears from the table 4 that 3.9 per cent of the households have strong economic condition and almost 93 per cent of the households under the category of low wealth index. It represents very poor economic condition of the sample households.

The educational attainment of parents might have impact on nutritional outcome of children. It also depicts the social status of the households which indirectly may influence on the health status of children. Especially mother's education has strong association with nutritional status of children as found by different studies. So, the educational achievement of parents is highlighted in the following table 5.

Table 5: Educational status of parents

Educational Level	Illiterate	1 to 4	5-9	10-12	12 pass	Graduate	Post Graduate
Number of mothers	320	163	543	214	80	83	12
% of Mothers	22.6	11.5	38.3	15.1	5.6	5.8	.08
Number of Fathers	308	206	506	185	98	100	12
% of Fathers	21.7	14.5	35.7	13	6.9	7	.08

Source: Field Survey

From the table 5, it is found that 22.6 per cent of mothers are illiterate or no schooling while 21.7 per cent of fathers have never gone to school. It is alarmingly high rate. As estimation of NFHS 5 Assam 19 per cent of mothers and 13 per cent fathers have no schooling in Assam. Only 11.48 per cent of mothers have completed higher secondary and more while 14 per cent of fathers have completed 12 years or more which is lower than the estimation of NFHS 5 Assam. It is notable that maximum parents are educated with 5 to 9 years of schooling in present study area.

Malnutrition trend in Assam:

The malnutrition trend depicts the vulnerability of malnutrition of a society over time. In spite of strong initiatives to eradicate the malnutrition problem through strong policy implementation yet the susceptibility of malnutrition even high in India that is manifested in different national level survey. The following table 6 presents the transition of malnutrition in Assam as well as in India over the period of time.

Table 6: Malnutrition trend in Assam

Districts	Underweight			Stunting			Wasting		
	NFHS4	NFHS5	Difference	NFHS4	NFHS5	Difference	NFHS4	NFHS5	Difference
Assam	29.8	32.8	3	36.4	35.3	− 1.4	17	21.7	4.7
India	36	32	−4	38	36	−2	21	19	−2

Source: NFHS 4 (2015-16) and NFHS 5(2019-20) Assam, India

The recent trend of malnutrition in India has shown a declining trend in all forms of malnutrition. Of course, the rate of declining is very low and the existing rates are alarmingly high as defined by UNICEF. It is highly disappointing that instead of decline of the burden of malnutrition in Assam, the rate of underweight and wasting children is increased by 3 and 4.7 points respectively from NFHS 4 (2015-16) to NFHS 5 (2019-20). Only stunting rate is declining by 1.4 during the period.

Table 7: Comparative analysis of stunting with NFHS 5 and Present Study

Child background characteristics	Study area of Assam			NFHS 5 Assam
	Total children	stunting children	% of stunting including ss	% of stunting including ss
Sex				
Male	900	426	47.3	35.6
Female	900	418	46.4	34.9
Age				0
< 6 months (m)	26	6	23.07	29.9
6 to 8 m	42	6	14.2	27.6
9 to 11	32	12	37.5	26.2
12 to 17	86	38	44.1	35.3
18 to 23	76	33	43.4	43.8
6 to 23 m	236	89	37.7	0
24 to 35 m	224	133	59.3	33.8
36 to 47 m	480	221	46	37.3
48 to 59 m	402	188	46.7	36.6
60 to 71 m	432	207	47.9	0
Birth Interval				
First Birth	798	346	43.3	33.3
< 24 m	114	55	48.2	42.8
24 to 35	358	191	53.3	41.2
36 and above	530	252	47.5	34.7
24 to 47 m	608	301	49.5	0
48 and above	280	142	50.7	0
Birth Order				0
1	798	346	43.3	33.3
2 to 3	926	459	49.5	35.4
4 to 5	70	33	47.1	43.1
6 and above	6	6	100	45
Mother's Education				0
No Education	440	271	61.5	42.1
< 5 Years schooling	220	131	59.5	40.6
5 to 7	362	186	51.3	40.1
8 to 9	338	145	42.8	33.7
5 to 9	700	331	47.2	0
10 to 11	194	54	27.8	28.1
≥12	246	57	23.1	27.1
BMI				0
Normal BMI	1228	498	40.5	35.2
Low BMI	572	346	60.4	41.3
Caste				0
SC	108	45	41.6	34
ST	250	100	40	30.7
OBC	1050	466	44.3	32.9
Others	392	233	59.4	37.4
Religion				0
Hindu	628	251	39.9	32.5
Muslim	1141	575	50.3	38.5
Christian	31	18	58.06	34.2
Location				0
Urban	806	363	45	29.8
Rural	994	481	48.3	36

Source: NFHS 4, NFHS5, Assam and India; field survey of the present study

The present study has found relatively higher rate of stunted children than the stunting rate estimated in the NFHS5 report for Assam among both male and female children. Female children are less prone stunting than male counterpart.

The present study shows the higher vulnerability of stunting among the children of age 12 months onward. Same trend is found in the estimation of stunting by NFHS5 Assam. Most vulnerable age group of children is 24 to 35 months in the study area while in accordance to NFHS5 Assam the children of age 18 to 23 months are highest vulnerability of stunting.

The least burden of stunting is noticed among the children who born at first in the report of NFHS 5 Assam and the present study while highest vulnerability is vivid in the report of NFHS 5 Assam among the children who born within very unhealthy birth interval i.e. less than 24 months. In present study the most vulnerable group of children is 24 to 35followed by 48 months and above months of children.

The stunting rate has increasing trend with the increase in birth order as depicted by the NFHS report of Assam and the present study. One similarity is observed in the NFHS report and present study in respect of prevalence of least stunting rate among the children of first order. Maximum rate of stunting is prevailed among the children of 2 to 3 birth order in the present study. The stunting rate found in the present study is higher than the rate estimated by the NFHS report.

A declining trend of stunting children is observed with the increase in educational attainment of mothers in the NFHS report and present study. The least burden of stunting is prevailed among the children of higher educated mothers in accordance to the NFHS report and present study while the maximum rate of stunting children is found among the children of uneducated mothers. The rate of stunting children is found higher in the present study among the children of all respective groups of mother's education than the rates found in the NFHS report.

Mother's nutritional status has positive association with nutritional outcome of children. The prevalence of stunting is lower among the children whose mothers with normal BMI than the children of underweight mothers as reported by the NFHS as well as present study. Moreover the rate of stunting found by present study is higher than the rate estimated by NFHS5 Assam in respect of both groups of children.

In Assam the stunting rate is lower among the children of ST community while the rate is higher among the children of others according to NFHS5 Assam and the present

study. The stunting rate found in present study is higher than the rate of stunting as estimated by NFHS5 Assam in respect of all categories of children of different communities.

Muslim children are more prone to stunting than Hindu children as depicted by present study as well as NFHS5 Assam. The maximum vulnerability is noticed among Christian children in the present study while it is highest among the Muslim children in Assamas found by NFHS5, Assam. In Assam the Hindu children have least vulnerability of stunting in accordance to present study and NFHS5, Assam. The stunting rate found in the present study is relatively higher than the estimation of the NFHS5 report regarding all categories of religion.

The present study shows the lower susceptibility of stunting in urban area than rural areawhich is also depicted in estimation NFHS5, Assam. In comparison to NFHS5, Assam, higher rate of stunting is noticed among both rural and urban children in the present study.

From the above discussion it is clear that almost similar trend of stunting in respect of different variables is observed in present study as observed in National Family Health Survey NFHS5 in Assam. Relatively higher vulnerability of stunting is noticed in the study area than the NFHS 5 report. The least vulnerability of stunting is reflected among the children of female, age of more than 12 months, first birth, higher educated mothers, good nutritional mothers, ST community, Hindu family and urban areas in present study as well as the report of the NFHS5 Assam.

On the other hand, the logistic regression model is considered to determine the factors affecting the states of malnourishment in terms of height for age of the children. In the regression model, height for age of the children is taken as the dichotomous dependent variable coding 0 for stunting 1 for normal height for age. The applied regression model is:

$$\ln\left(\frac{Y_i}{1-Y_i}\right) = \alpha + \beta_1 X_i + \beta_2 Y_i + \beta_3 Z_i + \ldots\ldots\ldots\ldots + \beta_n N_i + u_i$$

Where, Y_i is the predicted probability of normal height, $1 - Y_i$ is the predicted probability of having stunting, α is the constant of the equation, $\beta_1, \beta_2, \beta_3 \ldots\ldots \beta_n$ etc. are the coefficients of the predictor variables, such as X, Y, Z ..... N and u_i is the error term.

22 variables are considered as independent variables for the model. The variables are divided in three groups. Child specific characteristics- child sex and child age; Mothers related characteristics- Mothers' education, mothers' BMI, mothers' age at first birth, exclusive breastfeeding, food score, birth order, birth interval, Households' background

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characteristics- wealth status reflected by wealth index, family size, environmental status depicted by environmental index, occupation including agriculture, service, informal sector and business; caste including OBC, ST, SC, and others;Religion including Hindu, Muslim and Christian; location in terms of rural and urban; use of ICDS and quality of ICDS. The independent variables are considered on the basis of different literature and the factors that found in the study area which are related to undernutrition. After fitting the model, the multicollinearity is tested and due to high multicollinearity, the independent variable religion is discarded from the model. For occupational pattern the three dummy variables are introduced and the reference category is business. In respect of Caste three dummy variables are taken considering general caste as reference category and regarding quality of ICDS two dummy variables are considered keeping medium quality as reference category.

It is to be noted that the child age is measured in month; birth interval is measured in year; Food score is measured in numbers of food groups; Mother's education is considered in years of schooling, Mother's nutritional status is measured in BMI. The BMI value 18.5 is considered as normal and lower than 18.5 is considered as underweight BMI. The Wealth Status is measured on the basis of wealth index value. The result of the regression model is shown in the table 8.

Table 8: The result of the logistic regression when dependent variable is height for age

Variables	Odd Ratio	Co-efficient	St.Error	Z	P> |Z|
Child age (in months)	0.993	-0.0062**	0.003	-2.02	0.044
Birth Interval (in years)	0.9898	-0.0102***	0.003	-2.88	0.004
Food Score (no. of food groups)	1.833	0.606***	0.094	6.41	0.00
Mother's Education	1.056	.055***	0.016	3.32	0.001
Mother's N BMI=1,UW BMI=0	1.844	0.612***	0.113	5.39	0.00
WI	5.7996	1.702***	.565	3.02	0.003
cons	0.2088	-1.566	0.662	-2.37	0.018

*** indicates the significant at 1% level and ** indicates the significant at 5% level.

It appears from the table 8 that variable like age of the children, birth interval, food score, Mother's education, Mother's nutritional status, wealth status, have statistically significant association with the nutritional status of children. The other variables like sex of the children, birth order, exclusive breastfeeding, mother's age at first birth family size, occupational pattern, caste including OBC and SC and Schedule Tribe; location, utilization of ICDS and quality of ICDS have no statistically significant association with nutritional outcome of children.

The coefficient of the model regarding age of the children depicts the negative association of age of children with normal height of the children. One month increase in age of children decreases the chance of being normal height by 1 per cent which is statistically significant at 5 per cent significant level. On the other hand, the negative sign of co-efficient regarding birth interval indicates opposite association with normal height of the children. For increase in one year in birth interval the probability of being normal height decreases by 2 per cent.

Feeding of appropriate food has significant association with nutritional outcome of children. The children who consume appropriate food score are more likely to normal height. If the consumption of food score is increased by one more group of food the odd of normal height increases by 83 per cent. The relation is significant at 1 per cent level of significant.Another significant variable is mother's education. If the mother's educational attainment increases by one year of schooling the chance of being normal height of the children increases by 5 per cent.

Similarly, a positive relationshipis observed with respect to mother's nutritional status and nutritional condition of their children. The children are more likely to be normal height if their mothers are nutritionally strong. The odd of normal height increases by 84 per cent if the children belong to the mothers of normal BMI.

The wealth status of households has also strong relation with the nutritional status of children. The children of high wealth status households are more likely to be normal height than the children of relatively lower wealth status households. The odd value shows that if the wealth status of the household increases by .1, the odd of normal height of those children is 5.79 times greater than the children of households who have no chance to increase the wealth status by .1.

From the above analysis, it is observed that the variables like birth interval, food score, mother's education, mother's nutritional status and socio-economic standard depicted by WI are statistically highly significant. The nutritional status of children is strongly associated with these variables.

Discussion:

The present study has observed that the children of mother’s with no and lower schooling level have higher prevalence of stunting children than the children of educated mothers. The uneducated and lower educated mothers are not conscious about the healthy child rearing practices. Most of uneducated mothers are belonging to poor socio-economic

condition. Therefore, they have to work on daily wage basis for which rearing a child become a secondary or neglected part of their life. Similar observation is found in some other studies. The lower educated mothers have higher chance of being stunting children (Frongillo et.al 1997, Monteiro et. al 2010).The present study has observed that the children of undernourished mothers are more prone to stunting than the children of mothers with normal BMI. It is found that the mothers with low BMI have higher prevalence of ailment. Similar observation is noticed in some other studies. The children whose mothers have low BMI are more likely to be undernourished (Ntenda et.al 2018).The lactation capacity is less of underweight mothers and consequently the child also suffers from undernutrition (Hasan et.al 2016).

The present study has also observed that the children belonging to lower wealth index have higher susceptibility of underweight and stunting than the children of higher wealth index. It is observed that the households with lower wealth index are characterized by poverty with poor socio-economic condition, higher family size, poor environmental condition, lack of education, family planning and healthy child rearing practices. Higher household resources indicate the capability to provide appropriate highly nutrient foods and better child care (Heaton et.al 2016,Stewart et.al 2013,Zere et.al 2012). The study has found that the children of high educated mother from the household with high wealth index have less prevalence of undernutrition (Kimani et.al 2015, Frost et.al 2005).

Present study has found that the children who consume 4 or more than 4 food groups in a day are have less chance of malnutrition. But most of households are unable to provide sufficient complementary food to their children. Most of mothers are not aware about the complementary food even they have the capacity to provide. Child's diet quality is found to be significantly associated with mother's health and nutritional knowledge (Variyam, Blaylock and Lin, 1998).

Recommendation and conclusion:

The present study shows that age of children, mothers' education, mother's BMI, households' economic condition, food intakeare strong determinant of nutritional status of children. It is parents' education specially the mothers' education which has multiple effect on different variables such as mother's BMI, age at first birth, birth order, birth interval, food intake, socio-economic condition that ultimately affect on nutritional status of children. Therefore, government should take strong initiative for mother's education. The effective counseling programme is required for providing nutritional knowledge, child care practices,

correct feeding practices etc. In this respect, government may take strong initiatives through effective and proper implication of adult education, NRHM and ICDS. It is also to be mentioned here that the mothers are also equally responsible for improper implication of the scheme. Mothers must be conscious about the services provided by the schemes and must be aware to gather knowledge about the good health of the children. Besides mothers' education the proper infrastructural facilities, public health facilities, expansion of economic opportunities and equitable access to the facilities are basic requirement for sound health of children. Government should take strong initiatives in this respect.

Declaration of Interest:

The authors have no conflict of interest.

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A STUDY ON FACTORS AFFECTING THE TECHNICAL EFFICIENCY OF BETEL NUT PRODUCERS IN ASSAM

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Abstract:

Betel nut (Areca catechu) is one of the major plantation crops grown in Assam. However, due to inefficiency in production, the productivity of betel nuts in the state is very low. Therefore, this study attempted to measure the level of technical efficiency and factors affecting the technical inefficiency of betel nut growers in the Nagaon district of Assam.

Primary data were collected from 240 households in the Nagaon District of Assam. Based on the Cobb-Douglas production function for betel nut growers, this study uses stochastic frontier analysis to estimate the production frontier and examine the effects of exogenous variables on farm-level technical inefficiency.

The findings of the study reveal that, on average, 85 per cent of betel nut growers are technically efficient in the study area. Moreover, experience in betel nut plantations and gender have a significantly negative effect on technical inefficiency. By contrast, the age of the grower had a positive and significant effect on the technical inefficiency of betel nut cultivation. These findings suggest the availability of space for an increase in the productivity of betel nut plantations in the study area, and the scope for increasing the level of output through technical efficiency without raising inputs.

This study contributes to the estimation of technical efficiency of betel nut growers and examines the factors responsible for technical inefficiency. The original dataset was used in this study.

Keywords: Technical Efficiency, Cobb-Douglas, Maximum Likelihood Estimation, Stochastic Frontier Analysis

JEL Codes: Q12, D24, Q15, Q33, C61

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Introduction:

Initially native to Malaysia, betel nut, *Areca catechu* is cultivated widely in other South and Southeast Asian countries, including India, Bangladesh, Myanmar, Taiwan, Sri Lanka, Thailand, Bhutan, Nepal, and the Philippines. Data on betel nut production in India showed that it was the largest producer of betel nuts in 2019. India accounted for 52.3 per cent of the global areca nut production in 2019. In contrast, Bangladesh (18.4 per cent), Indonesia (8.7 per cent), and Myanmar (7.9 per cent) ranked second, third, and fourth, respectively, in betel nut production in 2019. However, Myanmar accounts for 56.6 per cent of global exports in 2020, with a U.S. $ 111.68 million market value. While Sri Lanka (26.24 per cent and market value U.S. $ 51.78 million), Indonesia (10.3 per cent and market value U.S. $ 20.22 million) and India (5.23 per cent and market value U.S. $ 10.31 million) ranked second, third and fourth positions respectively. In terms of import, it appears that India is the highest importer of betel nut (78.74 per cent and market value U.S. $ 75.45 million), followed by China (4.78 per cent and market value U.S. $ 4.58 million) and the United States of America (3.69 per cent and U.S. $ 3.54 million). Thus, the data reveal that India remains the major importer of betel nuts, although it produced more than 52 per cent of the global betel nuts in 2019. State-wise figures on betel nut production in India showed that Karnataka was the top-ranking state in terms of betel nut production in 2017 (63.16 per cent of total betel nut production in India). Kerala (15.88 per cent) and Assam (9.51 per cent) ranked second and third, respectively, in betel nut production in the same year. Table1 provides an overview of betel nut production and yield in India in 2017.

Table1: Production of betel nuts in India in 2017

Sl. No	State	Area (in '000 Hectare)	Production (in '000 M.T.)	Yield Per Hectare	Production Share (in per cent)
1	Karnataka	254.64	517.35	2.03	63.16
2	Kerala	98.52	130.10	1.32	15.88
3	Assam	80.81	77.90	0.96	9.51
4	Meghalaya	16.93	24.99	1.48	3.05
5	West Bengal	11.55	22.85	1.98	2.79
6	Tripura	5.99	20.41	3.41	2.49
7	Tamil Nadu	6.50	10.14	1.56	1.24
8	Mizoram	11.86	7.27	0.61	0.89
9	Maharashtra	2.31	3.41	1.48	0.42
10	Andhra Pradesh	0.56	2.37	4.23	0.29
11	Nagaland	0.39	2.37	6.08	0.29
	India	496.65	832.98	1.68	100.00

Source : Horticulture Statistics Division, Department of Agriculture, Coopn & Farmers Welfare & Author's calculation.

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Table 1 shows that the highest area under betel nut plantations was in Karnataka, followed by Kerala and Assam. As the case of production, however, the yield per hectare in Assam is very low among the major betel nut producing states in India. The highest yield was observed in Nagaland, followed by Andhra Pradesh, and Tripura. In Assam, the yield per hectare was only 0.96 metric tonnes. Betel nuts are a major horticultural crop that is planted in Assam. As shown in Table 1, approximately 80.81 thousand hectares of land in Assam are under betel nut cultivation, which is 16.27 per cent of the total betel nut plantation area in India. In contrast, Assam produces 77.90 thousand metric tons of betel nuts - 9.51 per cent of the country's total production during 2017. Nagaon district produces the highest number of betel nuts in Assam. In 2013, the district produced 15.1 per cent of its betel nuts in Assam. The cultivation and production of betel nuts in Assam is labor-intensive and involves a large number of laborers. This provides direct and indirect employment opportunities for both growers and traders. Thus, efficient use of production inputs is critical for betel nut growers to minimize production costs and maximize profits. From a policymaking perspective, it is crucial to improve productivity and production.

A low level of input utilization efficiency indicates a higher inefficiency of producers and vice versa. Hence, the estimation of technical efficiency and study of its factors are critical from an economic perspective. This study estimated the technical efficiency of betel nut growers in Nagaon, a major betel nut-producing district in Assam. This study uses stochastic frontier analysis (SFA) to measure the level of technical efficiency and discusses the factors that influence the level of inefficiency in betel nut production. Under this brief background, the main objective of the paper is to estimate the technical efficiency of betel nut growers in the study area. It further aims to study the factors affecting the level of technical inefficiency in betel nut production in the study area.

Database and Methodology:

This study used quantitative techniques to estimate the technical efficiency of betel nut farming. Social, economic, and demographic variables were considered to determine the determinants of technical efficiency or inefficiency. The Nagaon District of Assam was selected for this study because it has the highest betel nut production. The present study was based on primary data. However, secondary data were used to support this analysis. Primary data were collected through a direct interview method with the help of a questionnaire from 240 sample growers in the study area. In most agricultural studies, stochastic frontier analysis is used to determine technical efficiency in agriculture. Therefore,

the stochastic frontier production function was used to determine the technical efficiency of the betel nut growers. The 'Frontier (version 4.1c)' computer programme is used to carry out the analysis.

Theoretical Framework of the Study:

Many studies have found that many factors are responsible for the technical inefficiency in producing different varieties of agricultural products. Inefficiency results from social, economic, environmental, and demographic factors. Kalirajan (1981) viewed individual farmer variability as the primary cause of yield variability, rather than random variability. Kalirajan (1984) used individual technical efficiency measures to identify the factors causing variations in the efficiency levels of rice growers in the Philippines.

Kumbhakar et al. (1991) find that farmer education is essential for technical inefficiency. Moreover, their study revealed that large farms are technically more efficient than small and medium-sized firms. However, a survey conducted by Adesina and Djato (1996) found no difference between educated and uneducated farmers. They also found that access to extensions, modern varieties, and credit has no effect on the relative economic efficiency of small and large rice farms in Cote d'Ivoire.

Studies investigating technical, allocative, and economic efficiency have found that labor, herbicides, and fertilizers increase the level of production. By contrast, farmers' education, age, farming experience, and land size contribute positively and significantly to production efficiency (Parikh and Shah, 1995; Londiwe et al., 2014; Ali et al., 2019; Gogoi and Buragohain, 2019). The study made by Bravo-Ureta and Evenson (1994) found that the relationship between efficiency and various socioeconomic variables is not clear, and for which a clear strategy could not be recommended to improve performance.

Thus, from the literature, it was found that socioeconomic and demographic factors are the principal drivers of technical efficiency of growers of different crops. Existing literature suggests that both parametric and non-parametric approaches can be used to evaluate technical efficiency. Considering the merits and demerits of both approaches, the parametric approach, which allows us to use econometric techniques, is considered in the present study.

Stochastic Frontier Analysis:

Stochastic frontier analysis (SFA) was independently developed by Meeusen and Broeck (1977) and Aigner et al. (1977). Considering the advantage of allowing for the simultaneous estimation of the individual technical efficiency of respondent growers and

the determinants of technical efficiency (Battese and Coelli, 1995), this study used SFA to estimate the technical efficiency of betel nut growers in the Nagaon District of Assam. Assuming that the stochastic frontier production function follows the Cobb-Douglas form, a maximum likelihood estimation (MLE) is performed to determine the efficiency level. The Cobb-Douglas production function is the most used form of production in empirical studies on agriculture in developing countries (Abedullah et al., 2007; Ambalil et al., 2012; Ayaz and Hussain, 2011). Therefore, based on empirical studies, this study considers the Cobb-Douglas production function.

Following Aigner et al. (1977) and Meeusen and Broeck (1977), the stochastic frontier production function to determine technical efficiency and influencing factors can be expressed as:

$$Y_i = f(X_i; \hat{a}) \exp^{\{V_i - U_i\}} \qquad i = 1, 2 \ldots N$$

Here, Y_i is the output of the i^{th} firm, X_i is a vector of input quantities used by the i^{th} firm, â is a vector of unknown parameters to be estimated, and V_i is a random variable (independent of U_i) that is identically and normally distributed and captures the effects of statistical noise. U_i, assumed to capture technical inefficiency in production, is a one-sided non-negative variable that follows a half-normal distribution.

In the present study, the production function considered is in a log-linear form and can be expressed as:

$$\ln Y_i = \ln \hat{a}_0 + \sum_{j=1}^{N} \beta_j \ln X_{ij} + V_i - U_i$$

Based on the level of input used by growers, the technical efficiency (T.E.) of betel nut growers is defined in terms of the ratio of observed output (Yi) to the corresponding frontier output (Yi*). Thus, the technical efficiency of betel nut growers is as follows.

$$TEi = Yi/Yi^* \qquad (0 \leq TE \leq 1)$$

$$= f(Xi; \hat{a}) \exp(Vi - Ui) / f(Xi; \hat{a}) \exp(v) = \exp(-Ui)$$

The variances σ_v^2 and ,, and overall model variances were used to measure the total variation in output from the frontier under the following relationships:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \text{ and } \gamma = \sigma_u^2 / \sigma^2$$

where is the total output variation from the frontier, which can be attributed to technical inefficiency (Jondrow et al. 1982).

The economic inefficiency levels of betel nut growers and the factors affecting them can be expressed using the following inefficiency model.

$$Ui = \delta 0 + {}_i(Zi) \qquad i = 1, 2, \ldots\ldots\ldots N$$

Here, Ui is the inefficiency of the i^{th} betel nut grower and Z_i represents the factors affecting the inefficiency of the i^{th} betel nut grower. Additionally, U_i follows a half-normal distribution because the half-normal distribution of U_i provides a marginally better fit than the exponential distribution of U_i (Aigner, Lovell and Schimdt, 1957).

Empirical Model Estimation:

Existing literature suggests that social, economic, demographic, environmental, and institutional variables should be included in the models used to determine technical inefficiency factors. Some of the variables considered in the different studies were education, age, farming experience, access to credit, agricultural extension services, family size, gender, area under cultivation, irrigation, pesticides, and fertilizers. As in the study area, growers follow the most traditional mode of production without access to credit (since it does not require much cost to cultivate the betel nut; the only requirement is land, labor, and seed), agricultural extension services (which are virtually absent for betel nut cultivation), and the use of fertilizer (cultivators do not use fertilizer as the betel nut is traditionally cultivated). This study considered family size, grower experience, education, age, and gender to determine the level of inefficiency.

However, because labor, area under cultivation, and plants under the orchard are the only factors used to cultivate and produce betel nuts, only the Cobb-Douglas production function was used with these variables to estimate the technical efficiency of betel nut growers. Thus, the stochastic frontier production model specified in this study can be expressed as

$$\ln Y_i = \beta_0 + \beta_1 \ln(LAB)_i + \beta_2 \ln(BPLANT)_i + \beta_3 \ln(AREA)_i + v_i - u_i$$

$$i = 1,2,3,\ldots\ldots 240$$

where Yi is the yield of betel nut per year; LAB_i is, use of labor by the i^{th} betel nut grower measured in man-days per hectare; $BPLANT_i$ is, number of betel nut trees planted per hectare by i^{th} betel nut growers; $AREA_i$ is, area under betel nut cultivation measured in hectares by the i^{th} betel nut grower; v_i represents an error term, $N(0, \sigma^2)$; u_i, half normally distributed as $N(0, \sigma^2)$; β_0 is the intercept; and $\beta_1, \beta_2, \beta_3$ are the parameters.

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On the other hand, the technical inefficiency model considered for the study is expressed as below:

$$u_i = \delta_0 + \delta_1 (FAMSIZE)_i + \delta_2 (BEXP)_i + \delta_3 (EDU)_i + \delta_4 (AGE)_i + \delta_5 (GENDER)_i + \varepsilon_i$$

where u_i is the technical inefficiency of betel nut yield, $FAMSIZE_i$ is the number of family members of the i^{th} betel nut grower, $BEXP_i$ is the experience of the i^{th} betel nut grower in betel nut cultivation, EDU_i is the number of years of schooling of the i^{th} betel nut grower, AGE_i is the age of the i^{th} betel nut grower, GENDERi, Dummy for the gender of the i^{th} betel nut grower (1=male, 0=female), δ_0 is the intercept considered in the model, δ_1 to δ_5 represent parameters to be estimated, and ε_i is the error term with $N(0, \sigma^2)$.

Results and Discussion:

The overall objective of this study was to analyze the technical efficiency of betel nut growers in Assam, India. A study on technical efficiency shows that there is room to improve the use of inputs. Table 2 provides a summary of the variables considered for betel nut growers in the Nagaon District of Assam. Average betel nut production per grower was 1034.74 kg per hectare. The mean number of man-days used per hectare of land was 8.396, and the average number of planted trees plated was 171.46. The mean cultivation was .531 hectares. The average size of the betel nut growers was 5.487, whereas the average farming experience of growers was 13.73 years. The data related to education reveal that the average number of years of schooling is approximately nine years. The average age of betel nut growers is 55.53 years, indicating that the present generation does not consider betel nut cultivation a source of income. Finally, most betel nut growers were male (87 per cent).

Table 2: Descriptive statistics of quantities of inputs and outputs of the respondent

Variable	No. of Observation	Mean	Minimum	Maximum
Y (kg/hectare)	240	1034.74	300	3863
LAB (man-days/ hectare)	240	8.396	3	33.75
BPLANT (numbers of tree planted/hectare)	240	171.46	52.5	675
AREA (hectare)	240	0.531	0.2	1.33
FAMSIZE (numbers)	240	5.487	1	14
BEXP (years)	240	13.73	5	36
EDU (years)	240	8.97	0	17
AGE (years)	240	55.53	30	78
GENDER (1=male, 0=female)	240	0.87	0	1

Note: The figures in brackets show the units of measurement for the variables used in the stochastic frontier production function.

Table 3 presents the maximum likelihood estimates (MLE) of the production function of betel nut growers in the Nagaon district of Assam. It has been observed that the L.R. value is 13.9 and significant at 1 per cent level of significance. All the variables considered in this study were statistically significant. The coefficient for labor per hectare is 0.626 and is significant at the 1 per cent level of significance. Thus, a one-unit increase in labor leads to an increase of 0.626 units in total production, which is consistent with the findings of Iraizoz et al. (2003) and Binam et al. (2004). The number of trees planted per hectare was also significant at the 1 per cent level with a coefficient value of 1.129, which implies that a 1 per cent increase in the quantity of betel nut trees planted increases the level of betel nut output by about 1.129 per cent, ceteris paribus. This result is consistent with Sultan and Ahmed's (2014) finding.

The area under cultivation was significant at the 10 per cent level, with a coefficient value of 0.111, implying that a 1 per cent increase in the area under betel nut cultivation would lead to a 0.111 per cent increase in betel nut production. This result is consistent with those of Khan et al. (2010), Balde et al. (2014), and Fatima and Azeem (2015), who found that an increase in the area under cultivation increased the output level.

On the other hand, the inefficiency model provides an idea of the factors affecting efficiency. The negative sign of the parameters provides insight into the factors that may reduce efficiency, whereas a positive sign increases the technical efficiency in the model. In the present study, we found inefficiency that implied variation in output among betel nut growers in Nagaon district. The estimated gamma (ã) is found to be 0.75, which implies that 75 per cent of the total variation in output is due to technical inefficiency and 25 per cent variation is due to random variability. The mean technical efficiency of the betel nut growers was estimated to be 0.85. The negative technical inefficiency of betel nut growers has a positive effect on their technical efficiency. Thus, the negative signs in the inefficiency model indicate that family size, farming experience, and gender positively affected output. However, the positive signs for age and education of the grower variable indicate a negative effect on the output. However, the family size and education of the respondents were not statistically significant, which is supported by a study conducted by Adesina and Djato (1996) and contradicts the findings of Aye and Mungatana (2010).

Experience and age of grower: both variables were significant at the 1 per cent level. With increased experience, growers' productivity has increased. This is because growers with many years of experience in betel nut cultivation increase their managerial ability to optimally and efficiently use their limited resources. Therefore, they are more

likely to have higher outputs, and consequently, are more technically efficient. This result is consistent with that of Isaac (2011) and Abdulai (2013).

However, the production of betel nuts decreases with increasing age. A possible reason may be that, with an increase in age, they may not have enough desire to maintain their betel nut orchard. This could adversely affect the technical efficiency of betel nut production. This result is consistent with Bonabana (2002), Essilfie (2011), Addai and Owusu (2014), and Mesay et al. (2013), who find that older farmers could adversely affect their technical efficiency levels. On the other hand, studies by Eshete and Alamirew (2023) found the opposite; that is, with the increase in the age of producer productivity, productivity is directly related to growing experience with age.

However, the effect of gender was statistically significant at the 5 percent level. If growers are male, their productivity is higher than that of their female counterparts. One possible reason for this may be that females are physically weaker than males, whereas betel nut cultivation requires more physical strength. Moreover, females play a crucial role in household activities. Thus, this study found that male growers were more technically efficient than were females.

Table 3: MLE of the parameters of Stochastic Frontier C-D Production Function

Variables	Beta Coefficient	t-Statistic
Frontier Production Function		
Constant	3.323***	15.39
LAB (mandays/hectare)	0.626***	1.140
BPLANT (numbers of tree planted/hectare)	1.129***	11.62
AREA (hectare)	0.111*	2.331
Inefficiency Model		
Constant	0.0047	1.74
FAMSIZE (numbers)	-0.002	-0.0095
BEXP (years)	-0.025***	-4.023
EDU (years)	0.007	0.067
AGE (years)	0.008***	3.66
GENDER (1=male, 0=female)	-0.001**	-1.543
Sigma Squared (σ^2)	0.039***	10.95
Gamma (γ)	0.753***	9.87
LR	13.9^{***}	
Mean Efficiency	0.85	
N	240	

Note: ***= significant at the 1% level, **= significant at the 5% level, and *= significant at the 10% level

Output elasticity and returns to scale are also calculated to determine how efficiently the inputs are used, and whether returns to scale are increasing or decreasing. From Table 4, it appears that the estimated values of output elasticities for all inputs are positive. The elasticity of planted betel nut trees was 1.129. This may be because betel nut production increased in the new plantations. As expected, older betel nut trees might not have been produced. Only mature betel nut trees were produced at the highest levels. Labor is also a significant factor with an elasticity of 0.626 but is subject to decreasing returns. This may be because betel nut growers are mostly aged. As people age, their willingness to work also decreases. There were diminishing returns to the variable area with an elasticity of 0.111. An increase in the area under betel nut cultivation is not always beneficial, as it may become unmanageable with household labor only. In Assam, betel nuts are not fully cultivated on a commercial basis; rather, they are cultivated to supplement income and meet household demand. Recently, betel nuts have been cultivated commercially using traditional methods. However, the total output elasticity is 1.866, suggesting an increase in the returns to scale. More specifically, if the growers increased all inputs by 1 per cent, it will increase the betel nut production by 1.8 per cent.

Table 4: Estimation of output elasticities

Sl. No	Input Variable	Elasticity
1	Betel Nut Tree Planted	1.129***
2	Labour	0.626***
3	Area	0.111*
Total Output Elasticity		**1.866**

Note: ***= significant at the 1% level, **= significant at the 5% level, and *= significant at the 10% level

The mean technical efficiency of the betel nut growers was 85 per cent, ranging from 68 per cent to 100 per cent. The frequency distribution of betel nut growers, based on their technical efficiency, is shown in Figure 1.

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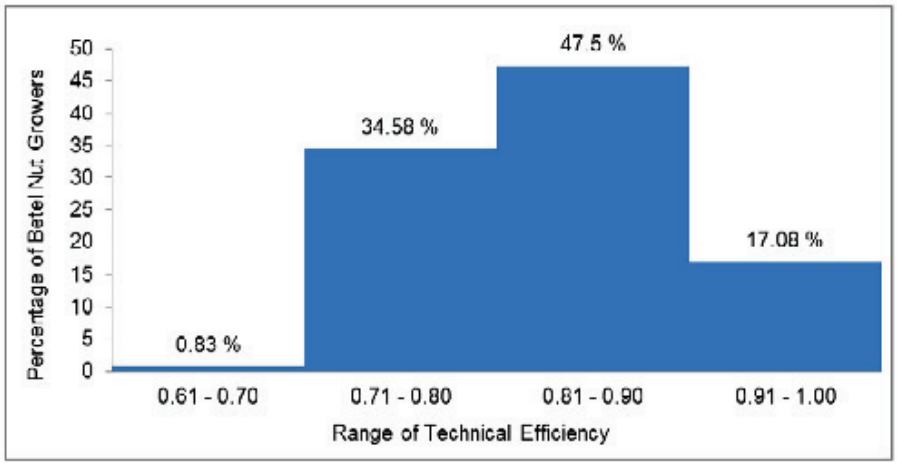

Figure1: Frequency distribution of betel nut growers based on their technical efficiency levels

Figure 1 shows that 0.83 per cent of the growers had technical efficiencies in the range 0.61 of 0.70. Between 0.71 to 0.80, 34.58 per cent of betel nut growers produced betel nuts. However, 47.5 per cent of growers produced in the range of 0.81 and 0.90. Finally, 17.08 per cent of the growers produced betel nuts at an efficiency level 0.91 of 100. Among the 240 betel nut growers, the technical efficiency of 35.41 per cent of the betel nut growers was less than 80 per cent. In contrast, 64.59 per cent of growers produced betel nuts with an efficiency range above 0.80. Thus, there is scope to increase the productivity of betel nut growers in the Nagaon district by increasing their technical efficiency.

Conclusion and Policy Recommendations:

This study focused on technical efficiency and its associated factors among betel nut growers in the Nagaon District of Assam, India. It appears from this study that the mean efficiency score was 85 per cent, indicating a potential loss of output due to inefficiency and suggesting considerable scope for improving productivity through input use. This study further reveals that an optimum level of output efficiency can be attained by using existing inputs.

Experience plays a major role in betel nut cultivation, based on the results of the technical inefficiency model. Empowering females can also increase growers' efficiency. The government should adopt appropriate policies to encourage women to grow betel nuts

and to provide incentives. Age is another significant factor determining inefficiency. With an increase in the age of betel nut cultivators, production falls; therefore, youth should be encouraged to cultivate betel nuts to generate income. In fact, information about the scope of betel nut cultivation as a source of self-employment should be disseminated among rural youths. Moreover, during the field survey, betel nut growers did not use chemical or organic fertilizers. If fertilizers are used for the cultivation of betel nuts, perhaps more production is possible and there are more returns to betel nut cultivation. It was also found that the role of agricultural extension workers was insufficient to address issues faced by betel nut farmers. There is a tremendous scope for increasing the efficiency of growers to increase the productivity of betel nuts in Assam. From this study, it appears that, without the use of pesticides, fertilizers, mulching, and irrigation, the returns to scale were estimated at 1.866. Thus, if betel nut cultivation can be modernized, it is clear that the betel nut of Assam is an important commercial crop for the state given its climatic and soil conditions.

Declaration of Interest:

The authors have no conflict of interest.

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Article in edited book

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Book by personal author(s)

Bhaumic, S.K. (1993). Tenacy Relations and Agrarian Development: A study of West Bengal, Sage Publications, pp.50-55.

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