# Technical Efficiency of Betel nut growers of Assam, India: A study in Nagaon District

A dissertation submitted to the Department of Economics, Mahapurusha Srimanta Sankaradeva Viswavidyalaya for the partial fulfillment of the degree of Masters of Arts(M.A)

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## CERTIFICATE

This is to certify that the dissertation titled "Technical Efficiency of Betel nut growers of Assam, India: A study in Nagaon District" submitted by **Ms Ruli Rekha Bora** (Roll No: ECO-01/23) in partial fulfillment of the requirements for the degree of **Master of Arts (MA) in Economics**, is a bona fide record of original research work carried out under my supervision. The contents of this dissertation have not been submitted for any other degree or diploma elsewhere.

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## DECLARATION BY THE CANDIDATE

I hereby declare that the work carried out in this M.A. Dissertation is my original work under the supervision of Dr. Dikshita Kakoti, Assistant Professor,Department of Economics, Mahapurusha Srimanta Sankaradeva Viswavidyalaya, Nagaon, Assam. The present research work has not been submitted previously at any other university or institution of higher education for the award of any other degree.

I have appropriately acknowledged the authors of the research publications by citing or quoting their works in the dissertation. I want to clarify that I have not intentionally included the research work of others reported in various sources of journals, reports, dissertations, theses or websites and claimed it as my own. Instead, I have properly cited these sources and credited them as references in my research work.

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# CHAPTER I

# INTRODUCTION

## 1.1: Background of the study

Betel nut is the seed of the fruit of the areca palm. Supari, paan and paangutkha are other names for it.It is also known as the Areca nut. The betel nut scientific name is Areca catechu. The betel nut is traditionally consumed by chewing, typically wrapped in a betel leaf with slaked lime (calcium hydroxide) and occasionally other ingredients such as tobacco. This distinctive combination is commonly referred to as a "betel quid" or Paan. Betel nuts used digestion, blood circulation, and glucose management while offering antimicrobial and anti-inflammatory benefits.. The betel nut has spreading its uses in Ayurvedic and veterinary medicines of animals.

The betel nut is native to tropical regions of the Pacific, South Asia and East Africa. Betel nut is cultivated in different climatic and soil conditions, particularly in India, Bangladesh, Sri Lanka, Malaysia, Indonesia, Philippines and Myanmar (Jose and Jayasekhar., 8). Under betel nut production India is in first position with respect to area (43.01%) followed by Bangladesh (33.00%), Indonesia (11.27%) and Myanmar (5.71%). Similarly, with respect to the production also India ranked first (50.37%) followed by Bangladesh (18.27%) Myanma (11.31%) and Indonesia (7.37%). Further, arecanut also cultivated in small scale in some countries like Nepal, China, Srilanka and Malaysia. The average productivity of arecanut at world level stood at14.60 q/ha. Among different arecanut growing countries, Srilanka stood first with a productivity of 35.14q/ha followed by Nepal was (33.10q/ha) and Myanmar (29.00q/ha). Although, India stands first in global production, its performance in productivity is poor with its global ranked 7th in terms of productivity with productivity level of 17.15q/ha which considered almost on par with world productivity level. (2021-22)

## 1.2: Brief History of Indian Betel Nut

The betel nut known as supari in India, has been an integral part of the country’s agricultural, cultural, and economic landscape for over two millennia. Historical evidence suggests its cultivation dates back to ancient times, with references in Vedic scriptures and Ayurvedic texts, which highlight its medicinal and stimulant properties. During the medieval period, betel nut became a symbol of social and ceremonial importance, widely consumed in royal courts and religious rituals. The colonial era marked a significant shift, as the British East India Company recognized its commercial potential and systematized its trade, leading to the establishment of large-scale plantations in regions like Karnataka, Kerala, and Assam. Post-independence, the betel nut industry witnessed further growth, supported by government initiatives such as the Horticulture Mission, which promoted modern farming techniques and improved processing methods.

In contemporary times, the focus has shifted toward enhancing technical efficiency in betel nut production to meet rising demand while ensuring sustainability. Key advancements include the adoption of high-yielding varieties, precision irrigation systems (e.g., drip irrigation), and integrated pest management (IPM) to optimize resource use. Mechanization has also played a crucial role, with innovations in dehusking, grading, and drying technologies reducing labor dependency and post-harvest losses. Furthermore, value-added products like flavored and processed betel nuts have expanded market opportunities. However, challenges such as climate sensitivity, price volatility, and environmental concerns (e.g., water usage and pesticide residues) necessitate a balanced approach to improve productivity without compromising ecological sustainability.

India is currently the largest producer and consumer of betel nut in the world. The crop is cultivated mainly in Southern India: Karnataka (largest producer), Kerala, and Tamil Nadu and Northeastern India: Assam, Meghalaya, and Tripura, where betel nut is deeply integrated into rural livelihoods and agro-based economies.India has witnessed significant changes in betel nut trends over the years, with noticeable growth in area under cultivation, total production, and productivity. These improvements can be attributed to factors such as technological advancements, increasing market demand, and supportive government policies. The following table presents the year-wise data on area, production, and productivity of betel nut in India from 2004–05 to 2021–22.

## 1.3 A Brief History of Assam's Betel Nut

The cultivation of betel nut (Areca catechu) in Assam has a rich historical legacy that shapes its contemporary production dynamics. Traditionally grown in homestead gardens and mixed-cropping systems, betel nut has long been intertwined with Assam's agrarian economy and socio-cultural practices. During the Ahom kingdom (1228–1826), betel nut was not only a staple in social and religious ceremonies but also a symbol of Assamese hospitality, often offered with pan (betel leaf) to guests.

The colonial period (19th–20th century) marked a shift toward semi-commercial cultivation, particularly in the Brahmaputra Valley, where fertile alluvial soils and a humid subtropical climate proved ideal for betel nut farming. Unlike the monoculture plantations of Karnataka and Kerala, Assam retained its traditional agroforestry approach, integrating betel nut with crops like paddy, coconut, and banana a system that enhanced ecological resilience but limited economies of scale.

Post-independence, betel nut gained prominence as a cash crop, especially for smallholders in districts like Kamrup, Nagaon, and Barpeta. Government initiatives, such as the introduction of high-yielding varieties (Mangala, Sumangala) by the Assam Agricultural University in the late 20th century, aimed to improve productivity. In Today, Assam ranks among India's top betel nut-producing states, yet yield gaps persist due to uneven adoption of modern technique.

## 1.4 Betel nut Production in Nagaon District

Nagaon district is one of the leading betel nut (arecanut) producing regions in Assam and holds a significant position in the state's agricultural economy. According to official records, the district had approximately 15,428 hectares under betel nut cultivation in the agricultural year 2019–20, with a total production of around 24,175.68 metric tonnes. The average yield during this period was estimated at 1,567 kg per hectare. Nagaon's share in Assam's total betel nut production is substantial; in 2013, the district alone accounted for about 15.1% of the state's overall output. The crop is primarily cultivated by small and marginal farmers, often using traditional farming methods that rely heavily on manual labor and indigenous knowledge. While these practices have contributed to the long-standing prominence of the crop in the region, they also highlight concerns related to low productivity and inefficiencies in input use. As a result, assessing the technical efficiency of betel nut production in Nagaon becomes critical to identify the gaps between actual and potential output. Improving efficiency through better resource management, extension services, and the adoption of modern techniques could play a vital role in enhancing farm profitability and sustainability in the district.

According to data from the Directorate of Economics and Statistics, Government of Assam, Nagaon produced approximately 7,264 metric tons of betel nut in the year 2017, positioning it among the top-producing districts in the state (Directorate of Economics & Statistics, 2020).The cultivation is predominantly carried out by small and marginal farmers. A study covering 240 betel nut growers in the district reported that 97.5% of them cultivated on garden sizes smaller than 7.5 bighas (approximately 1 hectare), indicating a dominance of smallholder production systems (*Borah, Dutta and Hazarika*(2020). Despite limited landholdings, betel nut farming has proven to be economically viable. The average cost of cultivation was reported at ₹5,111.29, while the average return stood at ₹21,411.11, highlighting the profitability of the crop (Kalita, 2020).Additionally, farmers in Nagaon frequently adopt mixed cropping systems, integrating betel nut with crops like betel leaf, paddy, and vegetables. This diversified approach not only maximizes land use but also stabilizes income and supports sustainable farming practices (Kakati, 2022).

In Nagaon district of Assam, betel nut (Areca nut) is widely cultivated due to the region's favorable agro-climatic conditions. The crop is grown primarily in homestead gardens and small-scale plantations across many rural and semi-urban areas. Some of the most prominent local areas in Nagaon where betel nut is abundantly available include:

a. Raha

Raha is a well-known area in Nagaon for betel nut cultivation. Farmers here commonly grow betel nut along with other crops like banana and black pepper in their homesteads.

b. Dhing

Dhing has a high concentration of agricultural households cultivating betel nut. The fertile soil and adequate rainfall support its production well.

c.Nonoi

In Nonoi, many households grow betel nut in their homestead gardens. The crop is often intercropped with other species like coconut, banana, or paddy.

d. Kampur

Kampur was located near the KapiliRiver,Kampur is another area where betel nut is widely grown. Many smallholder farmers depend on it for supplementary income.

e. Batadrava

Batardrava is known for its cultural and religious heritage, Batadrava also has numerous villages where betel nut cultivation is common in homestead gardens.

## 1.5 Review of Literature

Literature review is an integral part of any research work.Without having comprehensive literature review; it is not possible to move forward in a significant way for the research work. Thus, it can be stated that for a successful research work, one should have proper work on literature review. This section provides an overview of previous research work done on agricultural sectors, mainly focused on production and productivity, cost and profitability and technical or resource use efficiency of Betel nut.Many studies have found that many factors are responsible for technical inefficiency in producing different varieties of agricultural products. Inefficiency results from social, economic, environmental, and demographic factors.

G. Mula, S.C. Sarkar and A. Sarkar(2018) investigates the critical aspects of green arecanut processing in North-Eastern India, focusing on value addition and economic viability. This study highlights the economic significance of arecanut by examining its role in providing livelihoods to farmers and processors, particularly in rural areas. The researcher discuss various processing techniques, including drying, boiling and sliching which are essential for producing high quality areca nut products. This article likely contributes to the body of knowledge by providing empirical data and analysis on the economic feasibility of areca nut processing plants in this specific context, thereby informing policy decisions and supporting the development of the areca nut industry in the region.

Sangma and Joshi (2021) suggested the traditional processing, uses, and potential applications of areca nut husk. The researcher provides insights into conventional processing methods, such as drying and boiling, which impact the quality and commercial value of areca nut. It also highlights the diverse applications of areca nut, particularly in chewing products and medicinal uses. A key focus of the study is the potential of areca nut husk, which is often considered agricultural waste but has valuable industrial applications. The researcher suggests that areca nut husk fibres can be utilized in eco-friendly products. By emphasizing sustainable utilization of areca husk, the research contributes to both economic and environmental benefits, promoting waste reduction and additional revenue sources for farmers.

Jamanal and Murthy (2022) investigated the trends in areca nut cultivation in India, focusing on Karnataka. The study, based on secondary data, employs statistical tools such as arithmetic mean, coefficient of variation, and compound growth rates to evaluate these trends. The study has also been conducted to observe the many factors that contribute to the productivity of areca nut farms, such as climate, and technological advancements. The findings indicate that at the national level, the area under areca nut cultivation has been growing at a rate of 3.80%, production at 6.56%, and productivity at 2.66%. Karnataka, being a major producer, shows a higher growth rate in area (5.64%) and production (8.04%), though productivity has declined by 0.95%. District-level analysis reveals significant variations. In Dakshina Kannada, area (9.42%) and production (6.93%) have increased, but productivity has declined by 2.54%. Similarly, Chikkamagaluru and Shivamogga districts show an increase in cultivated area and production, but productivity has declined slightly. These findings highlight the need for improved agronomic practices and policy interventions to sustain productivity while maintaining growth in cultivation and production.

Acharya and Singh's suggested arecanut based cropping systems as a sustainable agricultural practice in North Eastern India, a region with favorable agro-climatic conditions for arecanut cultivation. Given the region's agro-climatic conditions, integrating arecanut with other crops can enhance land productivity, improve farmers' income, and promote ecological balance. The study emphasizes that areca nut-based inter cropping systems, which include crops like black pepper, banana, ginger, and turmeric, enhance resource utilization, improve soil fertility, and increase farm income. These systems also promote biodiversity and reduce the risk of crop failure.This study contributes to the growing body of knowledge on sustainable farming practices by evaluating the economic and environmental advantages of diversified cropping with arecanut.

Borah Durlove(2020) suggested the socio-economic conditions of betel nut farmers in the Nagaon district of Assam. The researcher explain that Nagaon district produces 12.84% of the total betel nut in production in Assam. The study is based on primary data collected from 240 betel nut growers across 12 villages in 2019. The cultivation practices in Assam are predominantly traditional, with marginal and small-scale farmers leading the production. Research has shown that betel nut farming in the region often employs mixed cropping systems, incorporating complementary crops like betel leaf, black pepper, and assorted vegetables.

Borah, Dutta and Hazarika(2020) investigates the economic, social and market dynamics of betel nut production in a regional context. The researchers' viewpoint was that betel nut production is a primary source of livelihood for numerous marginal and small-scale farmers in the region. The study underscores the economic feasibility of betel nut cultivation, especially in areas with limited alternative income-generating opportunities, thereby highlighting its significance as a vital livelihood strategy. This study highlights the importance of betel nut cultivation, its manufacturing processes, and its marketization, providing a comprehensive analysis of its role in the livelihoods of farmers and its integration into local and regional economies.

Arvind Kumar et al.'s (2021) investigates a comprehensive examination of areca nut use, practices, and dependency among Guwahati, Assam's population. The data used in this study is primary data and the data is relevant, up-to-date and specific to the population being studied. The researchers' highlights the cultural significance of areca nut, its consumption patterns, and associated health risks. The researchers' examines the level of dependency on areca nut among users, finding that a significant portion of the population exhibits signs of addiction or habitual use. Additionally, it identifies socio-economic factors influencing its use and underscores the need for public health awareness campaigns and policy interventions.

The 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, pesticide, and fertilizer. As in the study area, the 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 service (which is virtually absent for betel nut cultivation), and use of fertilizer (cultivators do not use fertilizer as the betel nut is traditionally cultivated). The present study considers family size, grower experience, education, age, and gender of the grower to determine the level of inefficiency.

### 1.6 Research Gap

Despite the significance of betel nut production in Nagaon district of Assam, there is a knowledge gap regarding the current status of this betel nut industry. Betel nut is commonly grown in Assam, but there is a lack of up-to-date information about how much is produced, the amount of land used for its cultivation, and its productivity specifically in Nagaon district. Previous studies have not presented a detailed analysis of the current production trends, yield patterns, and factors influencing fluctuations in betel nut production long with technical efficiency in Nagaon district. More research is required to define these challenges that face by Betel nut growers including environmental, technological, and market-related constraints and discover ways to boost sustainable production.Thus this research fills the gap by estimating the technical efficiency of betel nut growers and examines the factors responsible for technical inefficiency. The dataset is original and was especially collected for the present study.

### 1.5 Justification of The Study Area

For the convenience and relevance of this study, Nagaon district of Assam have been selected due to there is a large production of betel nut can be seen. Nagaon district of Assam has been selected as the study area for betel nut production due to its significant role in the state's agricultural economy and its favorable climatic and soil conditions. Assam is one of the largest betel nut-producing states in India, and Nagaon contributes substantially to this production. The district's humid subtropical climate, abundant rainfall, and fertile alluvial and loamy soils create ideal conditions for betel nut cultivation, ensuring high productivity and quality. Additionally, betel nut farming is a major source of livelihood for a large section of the rural population in Nagaon, making it an economically important crop. The district also serves as a key trading hub, with well-established market linkages facilitating both local and inter-state trade. However, farmers in the region face various challenges, including pest infestations, fluctuating market prices, and climate-related risks, which necessitate an in-depth study to identify sustainable solutions. Furthermore, there is limited research specifically focused on betel nut production in Nagaon, creating an opportunity to contribute valuable insights into improving cultivation practices, enhancing productivity, and strengthening the market potential of the crop. Therefore, selecting Nagaon as the study area for this dissertation will help in understanding the dynamics of betel nut production, addressing the challenges faced by farmers, and providing recommendations for the sustainable development of the sector. Nagaon district, located in Assam, covers a total area of 2287 square kilometers and The district has a total cropped area of 354801 hectares, with a cropping intensity of 179%.

## 1.8 Objective of the Study

Betel nut cultivation plays a vital role in the agrarian economy of Assam, offering both employment and income to a large segment of the rural population. Understanding the trends in its production and productivity, as well as the efficiency of farming practices, is essential for formulating effective strategies to enhance its sustainability. In this context, the present study was based on the following objectives:

1. To analyze the production, growth and the productivity of Betel nut in Assam.
2. To estimate technical efficiency and its determinants of Betel nut production.
3. To identify the problems faced by Betel nut growers.

## 1.9 Research Question

To better understand the dynamics of betel nut cultivation in Assam, particularly in districts like Nagaon, the following research questions can be explored:

1. What is the current production of betel nut production in Nagaon district of Assam?
2. What are the major factors affecting betel nut production in Nagaon district?
3. What are the challenges faced by betel nut farmers in Nagaon district?
4. Whether the Betel nut growers of sample area is technically efficient or not?

### 1.10 Data Source, Sample design and Research Methodology

This work is based on quantitative techniques to estimate the technical efficiency of betel nut farmers. Social, economic, and demographic variables are considered to determine the determinants of technical efficiency or inefficiency. The Nagaon district of Assam was purposively selected for this study because it has the highest betel nut production in Assam. The present study was based on primary primary data. However, secondary data were used to support this analysis.Secondary data were collected from Directorate of Economics and Statistics, Assam, District Agriculture Office, Nagaon etc. and also relevant books, research journals,Research theses and periodicals etc. Primary data were collected through a direct interview method with the help of a questionnaire from 100 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=7.1c)' computer programed is used to carry out the analysis.

The survey was undertaken by using pre-tested questionnaire. The questionnaire was designed to collect information about the socio- economic characteristics of the farmers. It was also designed to collect information relating to production activities, such as areas sown, level of input used, cost and output etc. The farmers were selected randomly for collection of required data. The data were collected through Personal Interview Method. The Collected data were tabulated in a systematic manner and analyzed using descriptive statistical methods, regression analysis, cardiograms etc. The Cobb-Douglas type production function was applied to estimate the elasticity of output with respect to inputs and a Stochastic Frontier Production Function was used to measure technical efficiency.

### 1.11 Analytical technique

Technical efficiency is the ratio between actual and potential output of production unit. Reviewed a few empirical studies, it was found that, their results of the studies were very useful for the policy maker for applying any developmental policies for a particular crop in particular region. In the present study, StochasticProduction Frontier (SPF) function was applied for data analysis. SPF is used todefine the maximum feasible or potential output that can be produced by a production unit such as a farm, with given level of inputs and technology. The actual production function can be written as;

$$Qi = f(Xi;\ \beta) exp\ (-ui\ )\ and\ 0 < ui\ < \infty; i = 1,2 \ldots, n. (1)$$

Where $Q_i$= Actual output for the $i^{th}$ sample unit; $X_i$= Vector of inputs used by the farm; β = A vector of parameters that describe the transformation process; f (.) is the frontier production function and $u_i$is a one sided (non-negative) residual term. If the production unit is inefficient, then its actual output is less than the potential output. Thus, by using equation(1),we can write the measure of the technical efficiency (TE) of the production units as below:

$$TE = Qi/f(Xi;\ \beta) = exp(-ui)(2)$$

Thus, if TE is less, the actual output is lower than that of potential output and vice versa. Again $u_i$is Zero if the production unit produces the potential output (full TE)and is less than zero, when production is below the frontier(less than full TE).In order to capture the effect of other omitted variables that can influence the output a random noise variable $v_i$is included in the equation (1) i.e.

$$Qi = f(Xi;\ \beta) exp(vi\ - ui)(3)$$

Where $v_i$ represents a random noise variable (independently and identically distributed normal with mean zero and variance $\sigma_v^2$ ). This new equation is known as the individual–specific Stochastic Production Frontier Function. The equation (3) can be measured by considering a half normal distribution for $u_i$(after empirical verification). The likelihood function for this model is-

$$L = -Nln\ \sigma - constant\ + \Sigma[ln\ \Phi\ (-\varepsilon i\ \lambda/\ \sigma) - 1/2\ (\varepsilon i/\sigma)2](4)$$

Where, $\lambda = \sigma_u/\ \sigma_v$,$\sigma^2 = \sigma_v^2 + \sigma_u^2$, and Φ is the cumulative standard normal distribution function and $\varepsilon_i$= ($v_i$- $u_i$); $\sigma_u$and $\sigma_v$ are standard deviations of the residuals u and v respectively. The Maximum Likelihood Estimation (MLE) method can provide the estimates of the Stochastic Frontier Production Equation. The individual specific TE is given by the conditional mean of exp (-$u_i$), given the distribution of the composite error term, $\varepsilon_i$.

Some other important parameters of the model are: $\sigma = \sqrt{(\sigma^2 + \sigma_u^2)}$, $\lambda = \sigma_u / \sigma_v$ ($> 0$) and $\gamma = (\sigma_u^2 / \sigma_v^2)$. A significant $\sigma$ (and $\lambda$) would indicate the significant variations in the output levels. The $\gamma$ term with value above one would indicate that output variations due to inefficiency are higher than that due to random factors. If $\gamma$ value would zero the nit indicates that the deviations from the frontier are dueentirely to the noise and in this case the Ordinary Least Squares (OLS) estimates of the model are equivalent to the MLE results and a value of one would indicate that all deviations are purely due to differences in TE across farms (Shanmugam and Venkatarmani, 2006).

There are various functional forms which can be used to estimate the Stochastic Frontier Production Function. In this study, the Cobb-Douglas type function was used as it is considered to provide the best fit. Therefore, the Stochastic Frontier Production Function is given by:

$$Log\,Y = a + b1 log\,X1 + b2\,log\,X2 + b3\,log\,X3 + b4 log\,X4 + b5 log\,X5 + b6 log X6 + b7 log\,X7 + \mu \;\ldots.(5)$$

Where, Y=out put per hectare

a=Intercept

b1 ----b7=Regression co-efficient represents out putelasticity.

X1=Seed cost in rupees per Bigha

X2= Human labour day per Bigha

X3 = NPK in kg per Bigha

X4 = Chemical cost in rupees per Bigha X5 =

Manure cost in rupees per Bigha

X6=Machinery cost in rupees per Bigha

X7 = Size of holdings

μ=disturbance term

The Maximum Likelihood Method (MLE) estimates of all the parameters of the Stochastic Frontier Production Model were obtained by using the relevant StatisticalSoftware Package.

## 1.12Tentative Chapterization

The study was classified into five chapters and each of them distinctly analyzes various points related to the different aspects of the study.

Chapter-I: **Introduction:** The first chapter provides an overview of Betel nut cultivation and its importance. Review of Theoretical and Empirical literature. It also discusses statement of the problem, objectives of the study, hypotheses, area of study and methodology.

Chapter-II: **Trends in area, production and the productivity of Betel nut in Assam and selected districts:**The second chapter consists of investigating trend of area, production and theproductivity of Betel nut in Assam and selected districts.

Chapter-III:**Socio-economic and General Characteristics of betel nut growers:**The third chapter discusses the Socio- economic characteristics of Betel nut growers and general characteristics of sample Respondents.

Chapter-IV: **Technical efficiency of Betel nut growers in Nagaon district of Assam:**The fourth chapter discuss the sample related Overall results and discussions.

Chapter-V: **Summary findings and Policy implications:**The last chapter presents the summary of the main findings, policy implications and conclusion of the study.

# CHAPTER II

# TRENDS IN AREA, PRODUCTION AND THE PRODUCTIVITY OF BETEL NUT IN ASSAM AND SELECTED DISTRICTS

## 2.1 Introductory statement

The chapter is based on secondary data collected from different sources for the objectives of the study. The secondary information were collected and used in the study. They are secondary data (time series data)on betel nut in area, production and productivity were collected from the records maintained by the Directorate of Ministry of Agriculture Directorate of Betel nut and Spices Development, Calicut at the national level data and Directorate of Horticulture at the state level data. For the purpose of evaluating the objectives of the study, based on the nature and extent of data availability, the following analytical tools was used for analyzing the data to draw meaningful results and conclusions.

## 2.2 Data and methodology

For computing compound annual growth rates of area, production and productivity of betel nut, the exponential function of the following form was used.

$$Y = abteU \ldots (1)$$

Where,

Y=Dependentvariable(Area/Productivity/Production)

a=Intercept term

b=Regressioncoefficient

(‘a’and‘b’aretheparameterstobeestimated) t = time period

$e^{U}$=Error term

The equation(1)was transformed into log linear form and written as;

$$logY = log\ a + t\ log\ b + Ut...(2)$$

Equation (2) was estimated by using Ordinary Least Squares (OLS) technique.
Compound growth rate(g) was then computed

$$g = (b - 1) \times 100 \ldots (3)$$

Where,
G=Compound growth rate in percent per annum b = Antilog of log b

The standard error of the growth rate was estimated and tested for its significance with 't' test statistic.

**2.2.1 Co-efficientof variation**

The coefficient of variation was used to measure the variability in area, production and productivity. The coefficient of variation or index of instability was computed by using the following formula-----

$$CV = \frac{Standard\ deviation(SD)}{Mean(X)} \times 100$$

**2.3 Results and discussions** This is including national trends and state wise patterns in betel nut cultivation.

**2.3.1 Trends in area, production and productivity of betel nut in India**

Fromthe table 2.3.1 and figure 2.3.2, in India, betel nut cultivation is largely found in Karnataka, Kerala, Assam Meghalaya, west Bengal and Tamil Nadu. Area under betel nut in India has increased gradually by more than two folds from 364.30 thousand hectares in 2004-05 to 731.65 thousand hectares during 2019-20. With respect to productivity, during 2004-05 it was at 1,243 kg per hectare and shown an upward trend i.e., productivity increased to 1,849 kg per hectare in 2019-20.The compound growth rate of area under Betel nut in India during 2004-05 to 2019-20 has found to be 3.80 percentwhich is significant at one percent probability level. The growth in production was found to 6.56 percent and significant at one percent level, which is more than the growth in area under betel nut. While the Productivity of betel nut found to be 2.66 percent. But later, in the year 2022–23, all three major indicators area, production, and productivity of betel nut continued to show a significant upward trend, reinforcing the long-term growth momentum observed in the sector.

The area under betel nut cultivation increased to 801.29 thousand hectares, compared to 731.65 thousand hectares in 2019–20, reflecting a sustained rise in land allocation for betel nut farming. This continued expansion may be attributed to the increasing commercial viability of betel nut as a plantation crop, farmer-friendly policies, and favourable agro-climatic conditions in the major producing states. Simultaneously, production rose to an impressive 1,498.33 thousand tonnes in 2022–23, up from 1,352.84 thousand tonnes in 2019–20. This rise in output reflects the combined effect of expansion in area and improved crop productivity. Increased access to quality planting material, better crop management practices, and mechanization may have contributed significantly to this enhanced output. Furthermore, productivity of Betel nut also followed an upward trend, increasing from 1,849 kg/ha in 2019–20 to 2,056 kg/ha in 2022–23. This substantial improvement in yield per hectare is a positive indication of growing efficiency in betel nut cultivation across India. Factors such as the adoption of scientific farming methods, efficient irrigation systems, improved pest and disease control, and capacity-building initiatives for farmers could have played a major role in this growth. The positive trends during the post-2019–20 period reflect not only the resilience of the betel nut sector but also the increasing reliance on it as a sustainable source of income for farming communities. It is noteworthy that the compound annual growth rates (CAGR) for the period from 2004–05 to 2019–20—3.80% for area, 6.56% for production, and 2.66% for productivity—set a strong foundation for the continued expansion observed in recent years. The relatively high $R^2$ values for each indicator (0.74 for area, 0.83 for production, and 0.78 for productivity) indicate a strong fit of the trend lines, further validating the consistency and reliability of this growth pattern.

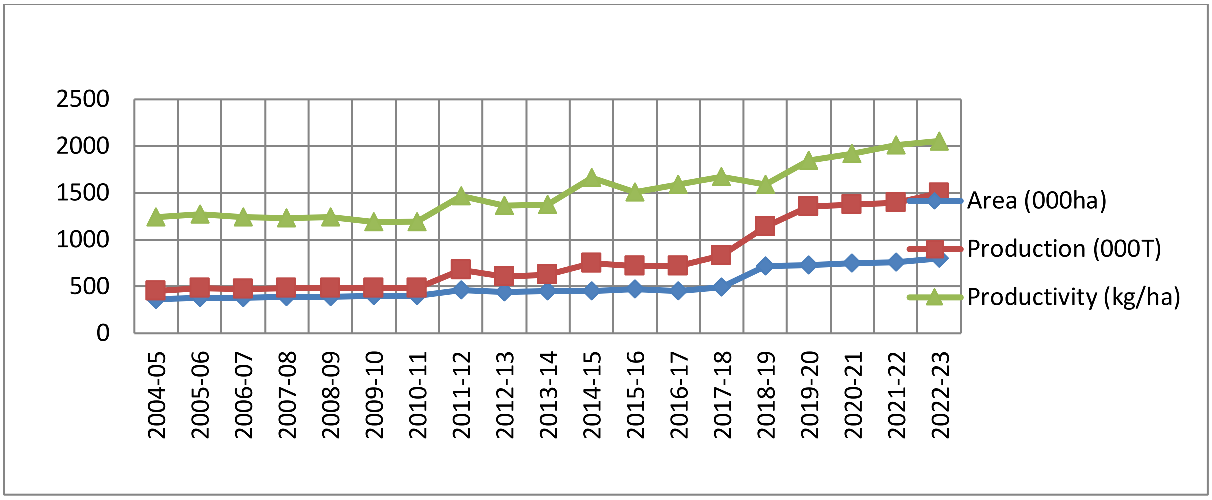
**Table 2.3.1:Trends in area,production and productivity of Betel nut in India (2004-05 to 2022-23)**

| Year | Area (000ha) | Production (000T) | Productivity (kg/ha) |
|---|---|---|---|
| 2004-05 | 364.3 | 452.7 | 1243 |
| 2005-06 | 381.1 | 483.1 | 1268 |
| 2006-07 | 382.38 | 473.23 | 1238 |
| 2007-08 | 386.69 | 478.07 | 1236 |
| 2008-09 | 387.1 | 481.3 | 1243 |
| 2009-10 | 400.1 | 478 | 1195 |
| 2010-11 | 400.3 | 478.1 | 1194 |
| 2011-12 | 463.9 | 680.7 | 1467 |
| 2012-13 | 446.39 | 608.72 | 1364 |
| 2013-14 | 451.9 | 622.27 | 1377 |
| 2014-15 | 450 | 747 | 1660 |
| 2015-16 | 474.36 | 713.84 | 1505 |
| 2016-17 | 454.65 | 722.85 | 1590 |
| 2017-18 | 496.65 | 832.98 | 1677 |
| 2018-19 | 718.41 | 1143.54 | 1592 |
| 2019-20 | 731.65 | 1352.84 | 1849 |
| 2020-21 | 745.11 | 1377.9 | 1921 |
| 2021-22 | 760.11 | 1400.19 | 2011 |
| 2022-23 | 801.29 | 1498.33 | 2056 |
| CAGR | 3.80** | 6.56** | 2.66** |
| R square | 0.74 | 0.83 | 0.78 |
| CV | 0.24 | 0.38 | 0.15 |
| Standard deviation | 110.06 | 258.3 | 205.75 |
| Mean | 461.87 | 671.83 | 1418.63 |

Source: researcher’s own calculation based on secondary data,2025

Betel nut cultivation in India has shown significant growth over the past two decades, with production increasing at a CAGR of 6.56%, far surpassing the growth in cultivated area (3.80% CAGR) and productivity (2.66% CAGR). The R-square values (0.74 for area, 0.83 for production, and 0.78 for productivity) indicate a strong time-dependent trend, meaning most of the variation in these parameters can be explained by yearly progression. R-square = 0.83 (Production). This means 83% of the variation in betel nut production over the years is explained by the time trend (year). A high R-square (close to 1) suggests a strong relationship between time and production, indicating that production has followed a relatively predictable upward trend. R-square = 0.74 (Area) and 0.78 (Productivity) 74% of area changes and 78% of productivity changes are explained by time, showing that these variables also follow a trend but with slightly more variability than production.CV (Coefficient of Variation) = 0.38 (Production) indicates high variability (38%)* in production relative to its mean. This suggests fluctuations in production due to factors like weather, pests, or market demand.CV = 0.24 (Area) and 0.15 (Productivity).Area under cultivation is less variable (24%) compared to production, while productivity (kg/ha) is the most stable (15%). SD (Standard Deviation) = 258.3 (Production).The average deviation of annual production from the mean (671.83 thousand tonnes) is ±258.3 thousand tonnes, showing significant year-to-year swings. SD = 110.06 (Area) & 205.75 (Productivity). Area varies by ±110,000 hectares, and productivity by ±206 kg/ha around their means.Mean Production = 671.83 (000 tonnes).The average annual production over 2004–2023 was 671,830 tonnes. Area = 461,870 hectares Productivity = 1418.63 kg/ha. These are the baseline values for comparison across years.

**Figure 2.3.1a:** Trends in area, production and productivity of betel nut in India (2004-05 to 2022-23)




**Source:** Researcher's own calculation based on secondary data,2025

### 2.3.2 State-wise area, production and productivity of betel nut in India (2022-23)

The cultivation of betel nut (areca nut) in India is concentrated mainly in a few southern and northeastern states. During 2022–23, Karnataka, Kerala, and Assam emerged as the leading producers. Karnataka had the largest area and highest production, followed by Kerala. Assam ranked third in both area and production but showed notable productivity levels. This state-wise data helps in understanding regional disparities and potential for betel nut cultivation across India.

**Table2.3.2: State-wise area, production and productivity of betel nut in India (2022-23)**

| States | Area (000ha) | Percentage share | Production (000 tonn) | Percentage share | Productivity (kg/ha) |
|---|---|---|---|---|---|
| Karnataka | 589.11 | 67.89 | 1081.84 | 79.97 | 2161 |
| Kerala | 89.11 | 15.22 | 92.76 | 6.86 | 957 |
| Assam | 79.23 | 12.88 | 50.04 | 3.7 | 747 |

| | | | | | |
|---|---|---|---|---|---|
| Meghalaya | 56.11 | 3.67 | 24.47 | 1.81 | 1363 |
| West Bengal | 28.11 | 3.91 | 23.86 | 1.76 | 2006 |
| Tamil nadu | 6.84 | 0.34 | 13.54 | 1 | 1979 |
| Andra Pradesh | 1.09 | 0.24 | 10.41 | 0.77 | 9505 |
| Goa | 1.97 | 0.27 | 3.7 | 0.27 | 1879 |
| Maharashtra | 3.11 | 0.36 | 5 | 0.37 | 1875 |
| Mizoram | 13 | 1.99 | 10.84 | 0.8 | 834 |
| Nagaland | 0.21 | 0.03 | 1.19 | 0.09 | 5540 |
| Tripura | 7.16 | 0.98 | 24.51 | 1.81 | 3420 |
| Andaman and Nicobar island | 4.33 | 0.59 | 10.58 | 0.78 | 2442 |
| Pondicherry | 0.05 | 0.01 | 0.07 | 0.01 | 1500 |
| India | 879.43 | 100 | 1352.81 | 100 | 36208 |

**Source:** researcher’s own calculation based on secondary data,2025

Table 2.3.2 presents detailed information on the area under cultivation, total production, and productivity of betel nut across major states in India for the year 2022–23. During this period, the total area under betel nut cultivation in the country was approximately 879.43 thousand hectares. Among all the states, Karnataka emerged as the leading contributor in terms of area, accounting for 589.11 thousand hectares, which is about 67.89% of the national total. Kerala followed with 89.11 thousand hectares (15.22%), while Assam stood third with 79.23 thousand hectares (12.88%). States like Meghalaya, West Bengal, and Tamil Nadu contributed smaller proportions, with area shares of 3.67%, 3.91%, and 0.34% respectively. Other minor contributors include Andhra Pradesh, Goa, Maharashtra, Mizoram, Nagaland, Tripura, the Andaman and Nicobar Islands, and Pondicherry.

In terms of production, India recorded a total betel nut output of approximately 1352.81 thousand tonnes during 2022–23. Once again, Karnataka led the country with a contribution of 1081.84 thousand tonnes, forming about 79.97% of the national output. Kerala and Assam were the second and third highest producers with 92.76 thousand tonnes (6.86%) and 50.04 thousand tonnes (3.70%) respectively. Other significant contributors included Tripura (24.51 thousand tonnes, 1.81%) and Meghalaya (24.47 thousand tonnes, 1.81%).In terms of productivity, which refers to the yield per hectare, the national average stood at 1538 kg/ha (calculated from the provided values: total production divided by total area = 1352.81 × 1000 / 879.43 ≈ 1538). However, wide inter-state variations were observed. Andhra Pradesh recorded the highest productivity with an impressive 9505 kg/ha, significantly surpassing the national average. This high yield may be attributed to more favourable agro-climatic conditions, suitable land topography, and possibly advanced cultivation techniques. Other states with relatively high productivity included Nagaland (5540 kg/ha), Tripura (3420 kg/ha), and the Andaman and Nicobar Islands (2442 kg/ha). On the other hand, states like Assam (747 kg/ha) and Mizoram (834 kg/ha) reported lower-than-average productivity levels.This data reveals that although Karnataka dominates both in area and production, states with smaller cultivation areas like Andhra Pradesh can achieve higher productivity levels through improved agricultural practices, suggesting the potential for yield improvement in other regions as well.

The analysis of betel nut cultivation in India from 2004–05 to 2022–23 shows a clear upward trend in area, production, and productivity. The area under cultivation more than doubled, and productivity improved from 1,243 kg/ha to 2,056 kg/ha. The compound annual growth rates for area (3.80%), production (6.56%), and productivity (2.66%) indicate significant and consistent sectoral growth. Karnataka emerged as the dominant producer, contributing nearly 80% of total output in 2022–23. However, wide disparities exist across states. Assam, while third in cultivated area, lags behind in productivity (747 kg/ha), far below the national average (approx. 1,538 kg/ha). In contrast, Andhra Pradesh and Nagaland, despite smaller cultivation areas, demonstrated remarkably high yields, suggesting better efficiency and advanced practices. These inter-state differences highlight the need for region-specific strategies to improve technical efficiency, especially in low-performing states like Assam.

This evaluation underscores the importance of improving input use, farming techniques, and support services to ensure more balanced and efficient growth in betel nut production across the country.

## 2.4 Conclusion

The analysis of betel nut cultivation in India from 2004-05 to 2022-23 reveals remarkable growth across all key parameters. The sector has demonstrated consistent expansion, with area under cultivation more than doubling from 364 thousand hectares to 801 thousand hectares, while productivity increased from 1,243 kg/ha to 2,056 kg/ha. This growth trajectory is particularly impressive in production terms, which grew at a robust 6.56% CAGR, significantly outpacing both area expansion (3.80%) and productivity gains (2.66%).Karnataka emerged as the dominant production hub, contributing nearly 80% of national output, though notable inter-state variations in productivity were observed. While some states like Andhra Pradesh achieved exceptional yields (9,505 kg/ha), others such as Assam lagged behind (747 kg/ha), highlighting significant untapped potential for yield improvement through better agricultural practices.The sector's strong performance, evidenced by high $R^2$ values (0.74-0.83) for growth trends, indicates stable, long-term development. However, the considerable production variability (CV=38%) suggests vulnerability to external factors like climate and pests. These findings underscore the need for targeted interventions including improved farming techniques, better input access, and region-specific strategies to enhance productivity, particularly in underperforming states.

Looking ahead, sustained investment in agricultural technology, irrigation infrastructure, and farmer training programs will be crucial to maintain this growth momentum. The betel nut sector's demonstrated resilience and commercial viability position it as an important contributor to India's agricultural economy, with potential for further expansion through strategic policy support and technological adoption.

# CHAPTER III

# SOCIO-ECONOMIC AND GENERAL CHARACTERISTICS OF BETEL NUT GROWERS

## 3.1:Introductory statement

India remains largely an agrarian economy, where plantation crops play an increasingly important role in enhancing rural livelihoods and contributing to the national economy. Among the various plantation crops cultivated across the country, betel nut (areca nut) holds a significant position, particularly in the state of Assam. In the Nagaon district, betel nut cultivation has been practiced for decades and has evolved into a major source of income for many farming households. The region has now reached near self-sufficiency in its production, reflecting both the suitability of the agro-climatic conditions and the adaptability of local farmers.

Chapter Three aims to present a detailed assessment of the present status of betel nut growers in the study area. The chapter covers key aspects such as the distribution of land utilization among growers, the demographic distribution of the sample households, prevalent mixed cropping systems, and the varieties of betel nut cultivated in the region. Additionally, it explores production levels, patterns of cultivation, and the costs associated with betel nut farming. Through this analysis, the chapter seeks to provide a comprehensive understanding of the current farming practices, economic viability, and livelihood implications of betel nut cultivation in Nagaon district.

## 3.2 Demographic Profile

In the context of betel nut production in Nagaon district, the demographic profile refers to the socio-economic and population-related characteristics of the betel nut growers in the area. It provides insights into the background of the farming community involved in this specific agricultural activity**.** The Demographic details of Nagaon district is Presented in Table 3.2

**Table 3.2 The Demographic details of Nagaon district**

| Particulars | Total | Percent |
|---|---|---|
| **Area** | 2,287 | - |
| **Population** | 28,23,768 | 100.00 |
| **Population density per sq. km** | 711 | - |
| **Male population** | 12,50,985 | 44.30 |
| **Female population** | 12,03,249 | 42.61 |
| **Literacy** | - | 72.37 |
| **Cultivators** | 2,87,452 | 29.33 |
| **Agricultural Laborers** | 1,07,649 | 10.98 |
| **Household and other industries** | 20,130 | 2.05 |
| **Other workers** | 3,19,762 | 32.68 |
| **Total workers** | 9,79,998 | - |
| **Percentage of workforce to total population** | | 34.70% |

Source: Census of Assam 2011

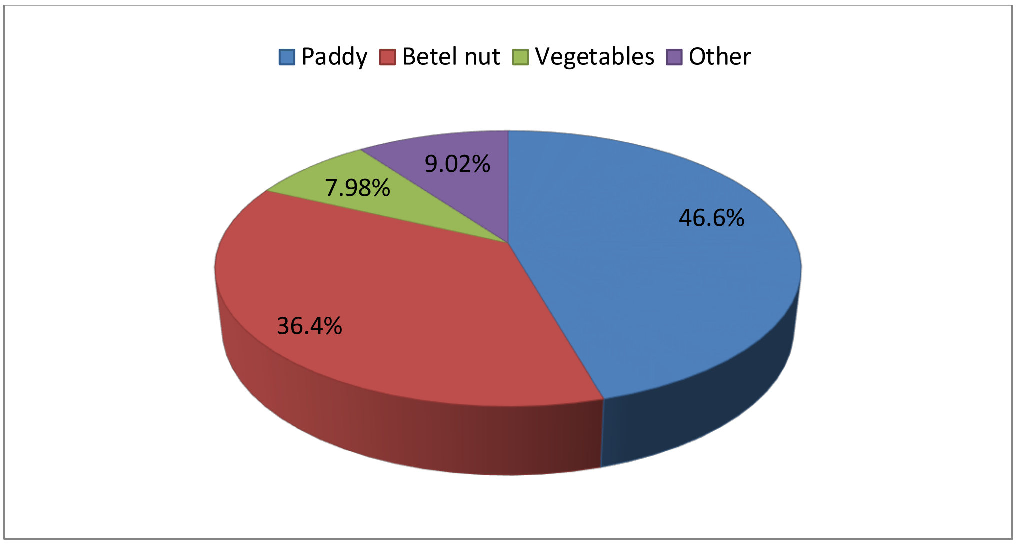
The population of the Nagaon district, as per 2011 census was 28.23 lakhs, of which 12.50 lakhs were males and 12.05 lakhs were females. The population density was 711 people per square kilometer. In Nagaon district, cultivators make up the largest share of the workforce at 29.33 percent, followed by other workers at 32.68 percent. Agricultural laborers account for 10.98

percent, while those engaged in household and other industries form a small portion of just 2.05 percent. Overall, the workforce represents 34.70 percent of the total population.

**3.3Distribution of Land Utilization by the Sample Betel Nut Growers**

The size of landholding is a crucial factor influencing agricultural productivity, particularly in the case of plantation crops such as paddy and betel nut. A landholding of economically viable size enables the farmer to adopt intensive cultivation practices, thereby enhancing land productivity. In this context, the pattern of land utilization reflects not only the extent of land under betel nut cultivation but also its distribution across other types of crops, along with any uncultivated or barren portions. The distribution of land among the selected betel nut growers in Nagaon district thus provides insight into their land use practices and cropping patterns. The following figure presents the land utilization pattern of the sample respondents engaged in betel nut cultivation in the study area.

**Fig 3.3: Distribution of Land Utilization by the Sample Betel Nut**




**Source:** Researcher's own construction

The above figure illustrates the land use pattern among the sample betel nut growers in Nagaon district. It reveals that a significant portion of their total land holdings, approximately 46.6%, is allocated to paddy cultivation, making it the dominant land use. Betel nut cultivation accounts for 36.4% of the land, highlighting its importance as a key crop for the growers. Additionally, 7.98% of the land is devoted to vegetable farming, while the remaining 9.02% is utilized for various other purposes.

### 3.4 Distribution of Sample Growers Based on Betel Nut Garden Size

As discussed in the previous chapter, Nagaon district in Assam is a prominent producer of betel nut. However, much of this production takes place in homestead gardens, primarily for household consumption, with only a portion being marketed locally. In the present study area, most of the betel nut gardens are relatively small in scale and are commonly measured in Katha and Bigha, a traditional local unit of land measurement. The following table presents the classification of the sample growers according to the size of their betel nut gardens.

**Table 3.4: Distribution of Sample Growers Based on Betel Nut Garden Size**

| Garden Size (Katha and Bigha | Number of Betel Nut Growers | Percentage |
|---|---|---|
| 2 katha | 08 | 16% |
| 3 katha-4katha | 20 | 40% |
| 1 Bigha-2Bigha | 22 | 44% |
| Above 2 Bigha | 0 | 0 |
| **Total** | **50** | **100** |

**Source:** Researcher's own construction

The above table shows that, out of the total sample grower 16 per cent growers (08) have betel nut gardens of 2 kathaland ,40 per cent growers (20) have betel nut gardens of 2katha-4katha land and 44 per cent growers (22) have betel nut gardens of 1Bigha-2Bigha and No growers are found having a garden more than 2 Bigha land. This implies that there is no betel nut cultivable garden covering above 2 Bighas of land owned by the growers. i.e. majority of the betel nut growers were marginal and small growers.

### 3.5 Mixed Cropping System of the Sample Betel Nut Growers

In the study area, the sample betel nut growers commonly practice a mixed cropping system to minimize the risks associated with sole betel nut cultivation and to enhance farm income. By integrating other crops alongside betel nut, growers are able to diversify their sources of revenue. Commonly adopted mixed crops include betel leaf, paddy, and various vegetables, which not only make efficient use of available land and resources but also contribute to the overall economic resilience of the farming households.

**Table 3.5:Distribution of sample growers on the basis of Mixed Farming System**

| Mixed Cropping System | Number Of Sample Growers | Percentage |
|---|---|---|
| Betel Nut+ Betel Leaf | 25 | 50 |
| Betel Nut+ Paddy | 18 | 36 |
| Betel Nut+ Vegetables | 07 | 14 |
| **Total** | **50** | **100** |

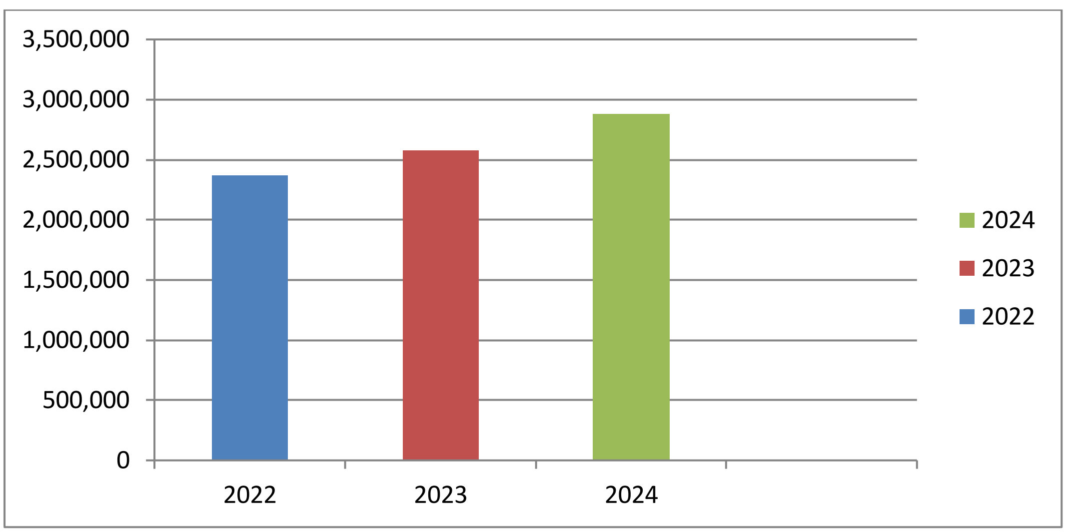
**Source:** Researcher's own construction

The above table 3.5 reveals that out of the total 50 sample Betel Nut growers 50 percent (25) growers have done betel nut with betel leaf cultivation which is the highest among all other mixed farming categories.36 per cent (18) growers have done betel nut with paddy and 14 per cent (7) growers have done betel nuts with seasonal vegetables.

**3.6 Production of Betel Nuts in the Study Area**

Betel nut production in the study area is measured in terms of betel nuts ready for market sale. While growers typically produce a sufficient amount, production has significantly declined over the past 2-3 years due to damage caused by squirrels and monkeys. Despite the relatively low maintenance required for betel nut cultivation, this pest issue has posed a major challenge, affecting yields and potentially impacting the livelihoods of growers in Nagaon district.

**Figure 3.6: Production of Betel Nut in terms of betel nuts (Kg) in the study area from 2021-22, 2022-23 and 2023-24**




**Source:** Researcher's own construction

The above figure 3.6 illustrates the production of betel nuts in terms of betel nuts (in kg) in the study area. Data on betel nut production were collected during the field survey in June 2025 for three consecutive years: 2022, 2023, and 2024. Although the figure indicates a year-on-year increase in production, betel nut growers continue to earn profits from cultivation.

### 3.7 General Characteristics of Sample Respondents

A survey of 50 betel nut growers was conducted across five villages in Nagaon district in 2025. The following socio-economic variables were recorded and later used as explanatory variables in the technical efficiency analysis: Age of house hold, Gender, Education, Farm size (in katha)and Experience in betel nut cultivation. These variables allow a multi-dimensional understanding of factors influencing technical efficiency among betel nut growers in the study area.

#### 3.7.1. Age Distribution of Sample Households

The age of the household head plays a pivotal role in defining farming practices and is particularly influential in the acceptance and use of climate-adaptive technologies. Hence the same is analyzed and the results are reported in table 3.7.1

**Table 3.7.1 Age Distribution of Sample Farmers**

| Age group | No. | Percentage to the total |
|---|---|---|
| 31-40 years | 6 | 12 |
| 41-50 years | 17 | 34 |
| 51-60 years | 18 | 36 |
| 61 -65 years | 9 | 18 |
| Total | 50 | 100.00 |

Source: Researcher's own construction

The age distribution of the 50 betel nut growers shows that a majority (82%) fall within the 31 to 60 years age group, with the highest share (36%) in the 51–60 years bracket, followed by 34% in the 41–50 years group. This indicates that most farmers are in their active and productive years, capable of effectively managing farm operations. Additionally, 18% are in the 61–65 years range, representing experienced cultivators. Overall, the presence of mainly middle-aged and older farmers suggests a stable and experienced workforce in betel nut cultivation.

### 3.7.2 Educational Status

The level of education plays a key role in shaping their ability to adopt new technologies and engage in community or social activities. Understanding the educational background of farm households is essential, as it influences the range of choices available to them. The educational levels of the households were examined, and the findings are summarized in Table 3.7.2, providing insights into the educational background of betel nut growers in the study area.

**Table 3.7.2 Educational Status of Sample Households**

| Category | No. | Percentage of the total |
|---|---|---|
| **Illiterate** | 2 | 4 |
| **Primary (Class I-V)** | 4 | 8 |
| **Middle school (Class VI-VIII)** | 13 | 26 |
| **HSLC (Class X)** | 12 | 24 |
| **HS (Class XII)** | 15 | 30 |
| **Graduate** | 4 | 8 |
| Total | **213** | **100.00** |

Source: Researcher's own construction

As shown in Table 3.7.2, the educational background of the 50 sample farm households reflects a varied level of formal education. A small proportion (4%) of respondents are illiterate, while 8% have completed primary education (Class I–V). The largest group (30%) has studied up to higher secondary (Class XII), followed by 26% with middle school education (Class VI–VIII) and 24% who have passed HSLC (Class X). Additionally, 8% of the respondents are graduates.This indicates that while a few lack formal education, a significant majority have attained at least secondary or higher education, which can positively influence their ability to adopt modern agricultural practices, stay informed about government schemes, and participate in community development.

### 3.7.3 Family Composition

The size of a household plays a crucial role in influencing both the income generation capacity of farm families and their ability to adopt new and innovative practices. Therefore, this aspect was carefully examined to understand its relevance to the study.

As shown in Table 3.7.3, the majority of respondents (70%) belonged to families consisting of 4 to 5 members, indicating a medium-sized household structure. Smaller families with up to 3 members accounted for only 22% of the sample, while larger families with 6 members represented 8%. This distribution provides useful insight into the family structure of the farming community under study.

**Table 3.7.3 Distribution of Family Size**

| Category | No. | Percentage of the total |
|---|---|---|
| **Up to 3** | 11 | 22 |
| **4-5** | 35 | 70 |
| **6** | 4 | 8 |
| Total | **50** | **100.00** |

Source: Researcher's own construction

### 3.7.4. Farming Experience

Farming experience is a critical factor that can significantly impact a farmer's efficiency, decision-making ability, and adaptability to new techniques. To understand this aspect, the number of years each respondent had been involved in farming was recorded and presented in Table 3.7.4.

**Table 3.7.4 Distribution of Family Experience**

| Experience (in years) | Total | Percentage of the total |
|---|---|---|
| **<10** | 11 | 22 |
| **11-20** | 26 | 52 |
| **21-25** | 13 | 26 |
| Total | **50** | **100.00** |

Source: Researcher's own construction

Table 3.7.4 indicates that most betel nut producers have significant farming experience. About 52% of the respondents had 11–20 years of experience, while 26% had 21–25 years. Only 22% had less than 10 years of experience. This suggests that betel nut cultivation in the area is largely managed by experienced farmers, which may contribute to better production practices and crop management.

### 3.7.5 Annual Income Levels of the Sample Farmers

It could be observed from Table 3.6.5 that the majority of the sample farmers (54 per cent) had an annual income ranging between Rs. 110000 and Rs. 150000, indicating that more than half of the respondents fall within a modest income bracket. This is followed by 30 per cent of farmers whose income ranged from Rs. 160000 to Rs. 200000, representing nearly one-third of the sample. A smaller proportion of farmers, about 8 per cent, reported earning up to Rs. 100000 annually, suggesting that very few farmers were in the lowest income group. Similarly, another 8 per cent of the sample had incomes in the Rs. 210000 to Rs. 250000 range, indicating a limited representation from the higher income category. Overall, the distribution of income among the farmers shows a concentration in the middle-income brackets, with fewer farmers at the extreme lower and higher ends of the income spectrum.

**Table 3.7.5 Annual Income Levels of the Sample Farmers**

| Annual income | Numbers | Percentage to the total |
|---|---|---|
| **Upto 100000** | 4 | 8 |
| **110000-150000** | 27 | 54 |
| **160000-200000** | 15 | 30 |
| **210000-250000** | 4 | 8 |
| Total | **50** | **100.00** |

Source: Researcher's own construction:

### 3.8 Frequency Analysis

Betel nut (Areca catechu) cultivation is a significant agricultural activity in Nagaon district, Assam, contributing to rural livelihoods and the regional economy.Understanding the frequency distribution of cultivation practices among growers provides critical insights into prevailing trends, challenges, and adoption rates of modern techniques. This analysis examines how frequently betel nut farmers engage in specific practices-such as irrigation methods, pest control, organic manure use, identifies dominant patterns in their farming systems.

The following table summarizes the key challenges faced by betel nut growers, based on survey responses. Problems are ranked by mean scores (1= Strongly Disagree, 5 = Strongly

Agree), along with their interpretations

**Table 3.8.1 Frequencies analysis of Betel nut Growers faced in Betel nut cultivation**

| Problems | Mean | Interpretation |
|---|---|---|
| Financial | 3.7 | Agree |
| Non availability of Skilled labour | 2.63 | Neutral |
| Shortage of water | 1.36 | Strongly Disagree |
| Load shading | 1.24 | Strongly Disagree |
| Insufficient organic manures | 2 | Disagree |
| High cost of organic manures | 2.18 | Disagree |
| Possibility of affected by disease | 3.45 | Agree |
| Loss due to animal attack | 4.65 | Strongly Agree |
| Lack of storage facility | 2.25 | Disagree |

**Source:** Researcher’s own construction

This table presents a quantitative analysis of challenges encountered by betel nut growers during cultivation, based on survey responses measured with a 5-point Likert scale (where 1 = Strongly

Disagree and 5 = Strongly Agree). The "Mean" column reflects the average severity of each problem, while "Interpretation" categorizes responses based on the scale.

1. Animal Attacks: The Most Severe Challenge (Mean = 4.65): Farmers strongly agree that crop loss due to animal attacks—particularly from monkeys, squirrels, and other wildlife—is the most critical issue faced in the cultivation process. This is a recurring and costly threat to productivity and requires urgent mitigation through fencing, repellents, or community-based crop protection strategies.
2. Financial Constraints (Mean = 3.70 – Agree)A high mean value signifies that access to capital and input costs are major barriers to successful cultivation.Growers may struggle with purchasing quality saplings, manure, or tools—highlighting the need for tailored credit schemes or subsidies.
3. Disease Susceptibility (Mean = 3.45 – Neutral to Agree): Farmers moderately agree that disease vulnerability (fungal infections, rot, etc.) impacts betel nut trees.This suggests that while disease is not as dominant a concern as animals or finance, improved disease management and access to agronomic advice are still relevant.
4. Non-Availability of Skilled Labor (Mean = 2.63 – Neutral): This issue ranks lower in severity, indicating that labor availability is not uniformly problematic, possibly due to reliance on family labor in homestead farming. However, in peak seasons, this could become more relevant and should be monitored in future assessments.
5. Low Concern Issues: Water Shortage (Mean = 1.36) & Load Shedding (Mean = 1.24): These very low means imply that farmers strongly disagree with the idea that water or electricity shortages are major hurdles. This reflects favorable local conditions or sustainable practices (e.g., rainfed farming) that reduce dependence on irrigation and power.
6. Organic Manure & Storage Facility Issues (Mean ≈ 2.00–2.25 – Disagree): Farmers generally disagree that the availability or cost of organic manure and lack of storage facilities are major problems.

**Table 3.8.2 Frequency Distribution of Marketing Challenges Reported by Betel nut Growers**

| Problems | Mean | Interpretation |
|---|---|---|
| Law demand | 4.14 | Agree |
| Law price | 3.46 | Neutral |
| Lack of regulated market | 2 | Disagree |
| Availability of substitute product | 4.84 | Strongly Agree |

Source: Researcher's own construction

This table highlights the major challenges faced by betel nut growers, including:

1. Critical Concern: Availability of Substitute Products (Mean = 4.84): Farmers strongly agree that the growing popularity of substitute products such as tobacco, areca-flavored alternatives, and packaged mouth fresheners severely affects the demand for raw betel nut.
2. Significant Problem: Low Demand (Mean = 4.14): A high mean score suggests that growers agree on the existence of declining demand in the market, possibly due to health concerns or changing consumer preferences.
3. Moderate Concern: Low Price (Mean = 3.46): Farmers gave neutral responses, indicating mixed experiences regarding pricing some may receive reasonable prices, while others face undervaluation.
4. Least Concern: Lack of Regulated Market (Mean = 2.00): The lowest mean score indicates that most farmers disagree with the notion that unregulated markets are a significant barrier.

### 3.9 Conclusion

The study highlights the importance of betel nut cultivation in Nagaon district, Assam. The findings suggest that betel nut growers in the region are mostly marginal and small farmers who practice mixed cropping systems to minimize risks and enhance farm income. The study also reveals that the majority of the sample households have significant farming experience and are in their active and productive years. However, pest issues pose a major challenge to betel nut production, affecting yields and potentially impacting the livelihoods of growers. Overall, the study provides valuable insights into the current farming practices, economic viability, and livelihood implications of betel nut cultivation in Nagaon district

# CHAPTER IV

# TECHNICAL EFFICIENCY OF BETEL NUT GROWERS IN NAGAON DISTRICT OF ASSAM

## 4.1 Introductory Statement

This chapter presents the empirical findings of the study, analyzing the technical efficiency of betel nut growers in Assam through a comprehensive econometric framework. The analysis is structured around three key methodological approaches to provide robust insights into production efficiency and its determinants.

First, descriptive statistics summarize the socio-economic and farm-specific characteristics of sampled growers, establishing the baseline profile of betel nut cultivation in the study area. Second a standard linear regression model identifies the factors contributing to inefficiency, offering actionable policy levers for productivity enhancement. Finally, the Stochastic Frontier Production Function is employed to estimate technical efficiency levels, quantifying the gap between observed and potential output

The findings from these analyses shed light on the current state of betel nut production efficiency, the extent of resource underutilization, and the socio-economic variables influencing farm performance. By integrating these results, this chapter not only diagnoses inefficiencies but also provides a foundation for evidence-based interventions to improve betel nut productivity in Assam. The discussion bridges econometric results with practical implications, ensuring relevance for policymakers, agricultural extension services, and farmers alike. The chapter is organized as follows: Section 4.1Stochastic Frontier Analysis 4.2 details the descriptive statistics, Section 4.3 presents the a standard linear regression model results.

## 4.2 Results and Discussions

This chapter presents the results of the analysis, starting with descriptive statistics, followed by regression analysis, and finally, the stochastic frontier analysis (SFA) models.

### 4.3 Descriptive statistics

The descriptive statistics provide a comprehensive overview of the socio-economic and production-related characteristics of betel nut growers in Assam. They offer valuable insights into the structure and scale of farming operations, input use, demographic profiles, and income levels. The data reveal considerable variation in output, input costs, landholding sizes, and tree density, suggesting heterogeneity in farm practices and productivity among farmers. Additionally, the figures highlight the socio-demographic background of growers, including limited formal education, substantial farming experience, and predominantly middle-aged to older farmers. Such information is critical for understanding the existing gaps in efficiency and the potential for improvement. Overall, descriptive statistics help lay the foundation for deeper econometric analysis by identifying key variables that influence production and may contribute to technical inefficiency in betel nut cultivation.

**Table 4.3: Descriptive Statistics of Betel nut production variables**

| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| output | 50 | 1314 | 624.186 | 520 | 2650 |
| land revenue | 50 | 364.72 | 139.179 | 150 | 700 |
| Manurecost~y | 50 | 855.36 | 394.126 | 250 | 1612 |
| Numbers_bn~d | 50 | 109.8 | 45.241 | 55 | 230 |
| education | 50 | 3.84 | 1.251 | 2 | 6 |
| experience | 50 | 15.18 | 5.1890 | 6 | 25 |
| age | 50 | 51.02 | 8.222 | 36 | 64 |
| Area_bn_cult | 50 | 4.7 | 2.375 | 2 | 10 |
| household | 50 | 4.26 | .943 | 2 | 6 |
| Annual income | 50 | 154200 | 37638.99 | 100000 | 250000 |

Source: Derived from STATA 11.

The table presents descriptive statistics for various variables related to betel nut farming.

The average betel nut output per farmer is 1314 kg, with a wide variation of 520 kg to 2650 kg indicating substantial differences in productivity. Farmers own around 110 betel nut trees on average, with the number ranging from 55 to 230 trees.

The average land revenue is approximately ₹364.72, and the average manure cost is ₹855.36, both showing considerable variation across farmers, reflecting differences in landholding and input usage.

In terms of socio-economic characteristics, farmers have an average education level of 3.84 years, with some having up to 6 years of schooling. The average farming experience is 15.18 years, and the average age of farmers is around 51 years, suggesting a relatively experienced but aging farming population.

Farmers cultivate betel nut on an average of 4.7 acres (or bighas, if local unit), with some cultivating up to 10. Most households consist of around 4 members, and the average annual household income is ₹1,54,200, with a wide income range (₹1,00,000 to ₹2,50,000), reflecting varying economic status. These descriptive statistics provide insights into the characteristics of betel nut farmers and their farming practices, which can inform strategies to improve productivity and efficiency.

### 4.4 Regression Results:

Linear Regression model serves as a conventional statistical approach to examine the linear relationship between betel nut output and selected explanatory variables, such as age, number of trees planted, area under cultivation, input costs, and socio-economic characteristics of the farmers. The purpose of employing this model is to identify which variables have a significant impact on productivity, without explicitly accounting for inefficiency. This helps in validating the results of the stochastic frontier model and offers an additional layer of analysis.The standard regression results also help highlight variables that may be included or further investigated in the efficiency analysis, particularly those with significant or marginal effects.This section discusses the estimated coefficients, statistical significance, and implications of the model in the context of betel nut cultivation practices in the study region.

**Table 4.4.1 Regression Result**

| Variables | coefficients | Std. error | t | p>t |
|---|---|---|---|---|
| avg | .0004599 | .0011931 | 0.39 | 0.702 |
| Manure cost | -.0014225 | .0007211 | -1.97 | **0.055** |
| numt | .0188108 | .0097291 | 1.93 | **0.060** |
| ex | -.290431 | .1945392 | -1.49 | 0.143 |
| age | -.0666302 | .0293048 | -2.27 | **0.028** |
| education | .0442212 | .1894909 | 0.23 | **0.017** |
| area | 1.568082 | 4.360249 | 0.36 | **0.021** |
| Households~e | -.1654824 | .2637962 | -0.63 | 0.534 |
| _cons | -15.99763 | 2.828896 | 5.66 | **0.000** |

Source: Derived from STATA 11.

**Number of Observation= 50**

**R- Squared= 0.8948**

**Adj R-Squared= 0.8692**

**Root MSE= 1.5342**

**F-statistics=2.25 with a p-value of 0.0032**

**Interpretation of the Results** The regression analysis reveals several key insights about betel nut productivity:- Farmer's Age shows a statistically significant negative relationship (p=0.028), indicating that older farmers tend to have lower productivity. Each additional year of age is associated with a 6.66% decrease in productivity, possibly due to reduced physical capacity or slower adoption of modern techniques.Manure Cost demonstrates a marginally significant negative effect (p=0.055), suggesting that higher input costs may constrain productivity.Number of trees show a marginally positive relationship (p=0.060), implying that farmers engaged in more market activities tend to have slightly higher productivity. Along with age, education and area under Betel nut production shows significant relation.Meanwhilehouseholdsize, and farming experience did not show statistically significant effects on productivity in this model.Average input use showed no meaningful impact (p=0.702).The R-squared value of 0.8948 indicates that the model explains about 30.5% of the variation in betel nut productivity.The adjusted R-squared of 0.8692 suggests that after accounting for the number of predictors, the explanatory power is more modest.

### 4.5 Stochastic Frontier Analysis

In this study, the analysis of technical efficiency among betel nut producers was carried out using the stochastic frontier production function (SFPF) framework. The estimation was performed through FRONTIER 4.1 and STATA software, which is widely applied in agricultural economics for analyzing production efficiency. The model specified a trans-log functional form, which allows for flexible interactions between the input variables and is particularly suited to capturing the complex relationships present in agricultural production systems.

#### 4.5.1 Estimated Coefficients and Interpretation

The estimated coefficients of the stochastic frontier model are presented in Table 4.1.1. The dependent variable in the model is the output of betel nut, while the independent variables include:

- Numt (number of trees per hectare)
- Manure cost
- Age (age of the farmer)
- Education level
- Area (area under cultivation)
- Household size

**Table 4.5.1: Stochastic Frontier Model Estimates for Betel Nut Production**

| Variable | Coefficient | Std. Err. | z-value | p-value | 95% Confidence | Interval |
|---|---|---|---|---|---|---|
| Productivity | -.000228 | .0002262 | -1.01 | 0.314 | -. 0006714 | .0002154 |
| Numt | .00116151 | .004768 | 2.44 | 0.015** | .0022701 | .0209602 |
| Manure cost | -.0017414 | .0006925 | -2.51 | 0.012** | -.0030985 | -.0003842 |
| Ex | -.3633243 | .1877976 | -1.93 | 0.053* | -.7314009 | .0047523 |
| Age | -.0758332 | .0193196 | -3.93 | 0.000*** | -.1136988 | -.0379675 |
| Education | .2704105 | .0398986 | 6.78 | 0.007*** | .1922106 | .3486104 |
| Area | 5.959159 | 1.127531 | 5.29 | 0.001*** | 3.749238 | 8.16908 |
| Households ~e | .1545614 | .0346857 | 4.46 | 0.005*** | .0865786 | .2225442 |
| _Cons | -17.79033 | .5598349 | 31.78 | 0.001*** | 16.69307 | 18.88759 |

Source: Derived from STATA 11.

Number of Trees (numt): The coefficient for the number of betel nut trees is 0.0116, and it is statistically significant at the 5% level (p = 0.015). This positive relationship indicates that as the number of trees increases, the total output also rises. This suggests that expanding the number of productive trees directly contributes to greater yield. Therefore, increasing tree density or plantation scale appears to be an effective strategy for improving betel nut production efficiency.

Manure cost: The coefficient associated with manure cost is -0.00174, and it is statistically significant (p = 0.012). This negative sign implies that after a certain point, higher expenditures on inputs such as labor, fertilizers, or pesticides may lead to diminishing returns. It suggests that inefficient or excessive use of inputs can reduce productivity rather than enhance it. This highlights the need for optimal input allocation and better cost management among farmers to achieve efficient production levels.

Experience (ex): The coefficient for farming experience is -0.3633, with a marginal significance level (p = 0.053). The negative sign indicates that longer years of farming experience may not necessarily translate into higher productivity. This counterintuitive result may be explained by the possibility that more experienced farmers might continue using traditional or outdated farming practices, rather than adapting to modern technologies and methods. Therefore, experience alone, without innovation, may not guarantee better outcomes.

Age: The coefficient for the age of the farmer is -0.0758, and it is highly significant (p = 0.000). This suggests that as farmers get older, their productivity tends to decrease. Possible reasons for this could include reduced physical strength, lower adaptability to new farming techniques, or a decline in risk-taking capacity. This finding emphasizes the importance of involving younger or more agile household members in key farming operations.

Education: The coefficient for education is 0.2704, which is positive and highly significant (p = 0.000). This result indicates that farmers with more years of formal education are more likely to be productive and efficient. Educated farmers may be better at interpreting agricultural information, adopting improved practices, and making informed decisions. Thus, education plays a crucial role in enhancing the technical efficiency of betel nut producers.

Area under Cultivation (area): The area of land used for betel nut farming has a coefficient of 5.9591, which is both large and statistically significant (p = 0.000). This strongly suggests that expanding the land area under cultivation leads to a substantial increase in output. It reflects the importance of land availability in driving production, particularly in a plantation crop like betel nut where output is closely tied to the extent of cultivated land.

Household Size:The coefficient for household size is 0.1546, and it is statistically significant (p = 0.000). This positive relationship indicates that larger households may be able to contribute more labor and management effort to farm operations, which in turn leads to higher production. This is particularly relevant in contexts where family labor is a primary source of manpower in farming activities.

Constant (_cons):The intercept or constant term in the model is 17.79, which is statistically significant (p = 0.000). This value represents the base level of output when all independent variables are held at zero. While not directly interpretable in practical terms, it serves as an important reference point for estimating the total output based on the input values in the model.

### 4.5.2 Variance Parameters and Technical Inefficiency

In the stochastic frontier production function (SFPF), the total deviation of observed output from the production frontier is composed of two types of error terms:

Random noise (v): Represents statistical errors or random shocks (e.g., weather variability, input quality, or measurement errors).

Technical inefficiency (u): Reflects how much output is lost due to suboptimal production practices or under-utilization of resources.

To analyze these, two key parameters are estimated in log form:

a. /lnsig2v: Log of the variance of the random noise term ($\sigma^2_v$)
b. /lnsig2u: Log of the variance of the inefficiency term ($\sigma^2_u$)

**Table 4.5.2: Variance Components and Inefficiency Indicators**

| Parameter | Coefficient | Std. Err. | z-value | p-value | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| /lnsig2v | -31.03138 | 226.2274 | -0.14 | 0.891 | -474.4289 | 412.3661 |
| /lnsig2u | 1.762485 | .2 | 8.81 | 0.000 | 1.370492 | 2.154478 |

**Source:** Derived from STATA 11.

1. /lnsig2v : The estimated coefficient for /lnsig2v is -31.03138, with a standard error of 226.2274. The associated z-value is -0.14, and the p-value is 0.891, indicating that this parameter is statistically insignificant. This means that the random error component (which accounts for uncontrollable factors like weather, pest attacks) contributes very little to the variation in betel nut output across farmers. The wide confidence interval also suggests high uncertainty around

this estimate. In essence, random shocks are not the primary reason for reduced productivity in this case.

2. /lnsig2u : The coefficient of /lnsig2u is 1.762485, with a standard error of 0.2, and a very high z-value of 8.81, which is statistically significant at the 1% level (p-value = 0.000). The 95% confidence interval ranges from 1.370492 to 2.154478.This indicates that technical inefficiency plays a substantial role in determining the level of output among betel nut farmers. In other words, the gap between actual and potential output is mainly due to inefficiencies in resource use or management, rather than chance or external disturbances.

### 4.5.3 Variance Components and Efficiency Ratios

The analysis of variance components and efficiency ratios provides further insights into the sources of variation in betel nut output and the level of technical efficiency among farmers.

**Table 4.5.3 Variance Components and Efficiency Ratios**

| Parameter | Coef. | Std. Errr. | 95% Conf. Interval | |
|---|---|---|---|---|
| sigma_ v | 1.83e-07 | .0000207 | 9.5e-104 | 3.50e+89 |
| sigma_u | 2.413897 | .2413898 | 1.98426 | 2.936561 |
| sigma2 | 5.826901 | 1.16538 | 3.542797 | 8.111004 |
| lambda | 1.32e+07 | .2413898 | 1.32e+07 | 1.32e+07 |

Source: Derived from STATA 11.

The estimation results from the stochastic frontier analysis reveal key insights into the nature of inefficiency and random error in the model. The standard deviation of the noise term (sigma_v) is estimated to be extremely close to zero ($1.83 \times 10^{-7}$), indicating that random external factors have a negligible impact on output variability. In contrast, the inefficiency term (sigma_u) is significantly larger, with an estimate of 2.41 and a narrow confidence interval, suggesting that inefficiency is the primary contributor to deviations from the production frontier.

The total variance of the composite error term (sigma2) is estimated at 5.83, reinforcing that inefficiency dominates the model's error structure. Most notably, the lambda value is extremely high ($1.32 \times 10^{7}$), which clearly indicates that the majority of the deviation in observed performance is due to inefficiency rather than statistical noise.

These findings suggest that there is considerable room for performance improvement among the units analyzed, as inefficiency rather than randomness is the key factor limiting output.

**Table 4.5.4 Estimated Parameters of the Stochastic Frontier Production Function and Technical Inefficiency determinants Model for Betel nut growers in Assam**

| Variables | Beta Coefficient | t-Statistic |
|---|---|---|
| **Frontier Production Function** | | |
| Constant | 3.323*** | 15.39 |
| LAND REVENUE (IN RUPESS/HECTARE | 0.626*** | 1.140 |
| NAMTREE(numbers of tree planted/hectare) | 1.129*** | 11.62 |
| AREA (hectare) | 0.111* | 2.331 |
| EXPERIENCE | | |
| **Inefficiency Model** | | |
| Constant | 0.0047 | 1.74 |
| FAMSIZE(numbers) | -0.002 | -0.0095 |
| BEXP(years) | -0.025*** | -4.023 |
| EDUCATION(years) | 0.007 | 0.067 |
| AGE(years) | 0.008*** | 3.66 |
| GENDER(1=male,0=female) | -0.001** | -1.543 |
| Sigma Squared($\sigma^2$) | 0.039*** | 10.95 |
| Gamma(γ) | 0.753*** | 9.87 |
| LR | 13.9*** | |
| Mean Efficiency | 0.85 | |
| N | 50 | |

*SOURCE: Derived from STATA,11 APPLICATION.*

*Note:* Significantatthe1%level,**=significantatthe5% level and*=significantatthe10%level.

Table 4.5.4 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 variables considered in this study were statistically significant. The coefficient for land revenue is 0.626 and is significant at the 1 per cent level of significance. Thus, one unit increase in labor leads to an increase of 0.626 units in total production, which is consistent with the studies 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. The area under cultivation is significant at the 10 per cent level with a coefficient value of 0.111, which implies that a 1 per cent increase in area under betel nut cultivation will lead to a 0.111 per cent increase in betel nut production.

On the other hand, the inefficiency model shows that inefficiency effects are present in the model, implying variation in output among betel nut growers in the Nagaon district. The estimated gamma ($\gamma$) 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 0.90. The negative technical inefficiency of betel nut growers has a positive effect on their technical efficiency. Thus, the negative signs in the inefficiency model show that family size, farming experience, and gender positively affect output. On the other hand, the positive signs of age and education of the grower variable indicate a negative effect on output. However, the family size and education of the respondents were not statistically significant.

Experience and age of the grower: both variables are significant at the 1 per cent level. With increased experience, growers' productivity increases. This is because growers with many years of experience in betel nut cultivation increase their managerial ability to make optimal and efficient use of their limited resources, and, therefore, are more likely to have higher outputs and, consequently, more technically efficient. However, with increasing age of betel nut growers, the production of betel nuts decreases. A possible reason may be that with an increase in age, they may not have enough desire to maintain their betel nut orchard. This can adversely affect the technical efficiency of betel nut production.

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

In the case of betel nut farming, the stochastic frontier results show that the majority of output variation is due to technical inefficiency, not random factors like climate. The inefficiency effect ($\sigma_u$) is much larger than the random noise ($\sigma_v$), and the lambda value is extremely high, confirming this. This suggests that improving farming practices, technology use, or input efficiency could significantly boost production. In the inefficiency model, the variables- family size, years of formal education and farming experienced has also examined to check the efficiency separately. The sign of the coefficients of these variables has an important policy implications that, negative sign signifies a positive effect on efficiency while positive sign implies negative effect on the efficiency of the organic tea growers. The variables, education and farming experience have positive impact to increase the efficiency level of the organic tea growers while household size and training has negative impact on efficiency of the organic tea growers. Theoretically it is also accepted that education and farming experience can increases the efficiency level, because these factors increases the marginal skills of the growers. From the result, it is also found, the coefficients of household size have significant impact to improve the efficiency level of betel nut growers. This is happen due to inadequate training facilities among the growers and it is like one day in a year. Also, the trainings the growers already taken are not formal. The variable, size of the family also does not matter to improve the efficiency level of the organic tea growers. It implies all the members of the sample households are not involved in this particular sector.

### 4.6 Individual and mean technical efficiency scores of Betel nut growers

The study also determined the individual technical efficiency scores and mean technical efficiency score of the Betel nut growers. The following Table 4.4 shows the individual and mean technical efficiency scores of Betel nut growers.

**Table4.6**Distribution of Individual Technical Efficiency Score of the Betel nut Growers

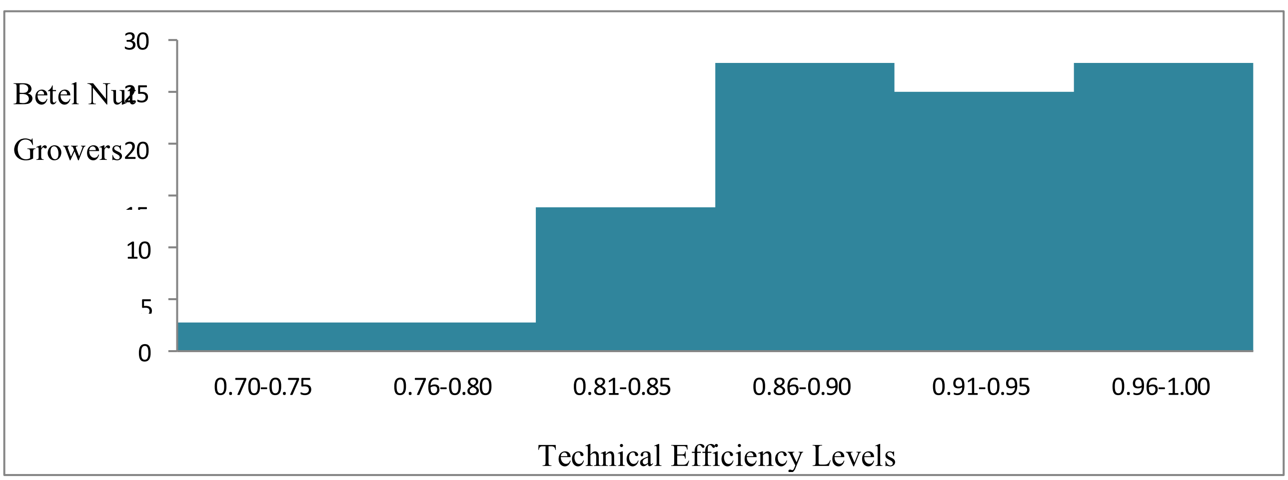
| **No. of Grower** | **Technical Efficiency score** | **No. of Grower** | **Technical Efficiency score** |
|---|---|---|---|
| 1 | 0.87626151E+00 | 26 | 0.8764147E+00 |
| 2 | 0.83200169E+00 | 27 | 0.8632442E+00 |
| 3 | 0.88641843E+00 | 28 | 0.8722061E+00 |
| 4 | 0.86998896E+00 | 29 | 0.8699931E+00 |
| 5 | 0.84428854E+00 | 30 | 0.8992366E+00 |
| 6 | 0.88381556E+00 | 31 | 0.7956717E+00 |
| 7 | 0.79620451E+00 | 32 | 0.9158309E+00 |
| 8 | 0.86246743E+00 | 33 | 0.95777995E+00 |
| 9 | 0.86633705E+00 | 34 | 0.83276336E+00 |
| 10 | 0.95884302E+00 | 35 | 0.99283935E+00 |
| 11 | 0.90177599E+00 | 36 | 0.94197244E+00 |
| 12 | 0.82746257E+00 | 37 | 0.92365004E+00 |
| 13 | 0.87656166E+00 | 38 | 0.99223913E+00 |
| 14 | 0.88271472E+00 | 39 | 0.94428753E+00 |
| 15 | 0.89024864E+00 | 40 | 0.95738297E+00 |
| 16 | 0.95063102E+00 | 41 | 0.98559616E+00 |
| 17 | 0.96052857E+00 | 42 | 0.85399153E+00 |
| 18 | 0.96878178E+00 | 43 | 0.99885144E+00 |
| 19 | 0.94766173E+00 | 44 | 0.81626741E+00 |
| 20 | 0.99886980E+00 | 45 | 0.94778215E+00 |
| 21 | 0.74025505E+00 | 46 | 0.8990411E+00 |
| 22 | 0.95900785E+00 | 47 | 0.93145741E+00 |
| 23 | 0.96905503E+00 | 48 | 0.889964598E+00 |
| 24 | 0.96836508E+00 | 49 | 0.953632289E+00 |
| 25 | 0.99372688E+00 | 50 | 0.94731887E+00 |

| MeanTechnicalEfficiency |
| --- |
| .907E-01 |

Source: Derived from system, Frontier 4.1

Table 4.6 shows the mean technical efficiency of the Betel nut growers is 0.90. This implies, on an average the Betel nut growers of Nagaon district of JengoniChuk and GumutaGaonfelt short of maximum frontier level of technology by 9 percent. There is a potentiality to improve the level of total output by enhancing the technical efficiency of organic tea growers of Nagaon district. The mean technical efficiency score of the betel nut growers 0.90 is ranges between 0.74 and 0.93. The following Figure 1 represents the frequency distribution of Betel nut growers in the study area with respect to their technical efficiency levels.

**Figure4.7 Frequency Distribution of Betel nut Growers based on their Technical Efficiency Levels**




Source: Derived from system, Frontier 4.1

From Figure 4.4.1 highest percentage of betel nut growers are concentrated in the technical efficiency score range of 0.81-0.90 and 0.90-1.00. The lowest percentage is concentrated in the technical efficiency score groups of 0.70-0.75 and 0.76-0.79. After considering the efficiency score of all the 50 betel nut growers the mean technical efficiency score is found to be 0.90. Among all the sample betel nut growers, 90 percent growers had technicalefficiencies≥0.80.This implies that betel nut growers of Nagaon district are highly efficient in the allocation and management of the resources that have been used in their firms.

### 4.8 Conclusion

From the study it is found the Betel nut growers can increase more of their output by increasing their inputs scale. The inputs like organic fertilizer, organic pesticide, manure are the major factor that can enhance the output level of the growers. The study also found the mean technical efficiency of organic tea growers is 0.90. It means there is a scope of 90 percent to increase the technical efficiency. The technical efficiency can be increased by increasing education and farming experience among the growers. Increase in technical efficiency can leads to increase the output level in future. In this sense, the country like India, the role of fiscal authority is very necessary for better education facilities among the growers Financial support is also a crucial factor to improve the organic tea growers. Because adequate financial facilities can leads to do work efficiently. This will leads to improve greater experience and make the growers skilled. Greater experience can increase the technical efficiency of the growers and leads to increase the output level in future.

From the results of the technical inefficiency model, it is evident that experience plays a major role in betel nut cultivation. Moreover, empowering females can also increase efficiency among growers. The government should adopt appropriate policies to encourage women to grow betel nuts, and provide incentives. Age is another significant factor determining inefficiency. With the 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, it was found that 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 the issues of betel nut growers. There is tremendous scope for increasing the efficiency of growers to raise 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.

# CHAPTER V

# SUMMARY FINDINGS AND POLICY IMPLICATIONS

## 5.1 Introductory Statement

This final chapter presents a comprehensive summary of the key findings of the study on the technical efficiency of betel nut growers in Assam. The research aimed to assess the level of technical efficiency among farmers, identify the major socio-economic and farm-level factors influencing their productivity, and suggest suitable measures for improving overall performance. By employing descriptive statistics, standard linear regression, and the stochastic frontier production function, the study provided both quantitative and qualitative insights into the nature of betel nut farming in the region.

The chapter begins with a concise summary of the main empirical results derived from the previous analysis. It then outlines the policy implications based on the observed inefficiencies and determinants of production. Finally, the chapter concludes with key takeaways from the study and offers suggestions for future research and policy interventions aimed at enhancing the efficiency and sustainability of betel nut cultivation in Assam.

## 5.2 Summary of Key findings (Objective-wise)

### 5.2.1 Objective 1: Production, Growth and Productivity of Betel Nut in Assam

- Assam is the third-largest producer of betel nut in India, accounting for around 12.88% of the national cultivation area. However, despite its significant share in area, the productivity in Assam is relatively low at 747 kg per hectare, which is much below the national average of 1,538 kg/ha.
- Betel nut occupies 36.4% of cultivated land, second only to paddy (46.6%), indicating its economic significance.
- Over the years (2004–05 to 2022–23), Assam has shown a modest annual growth rate of 2.66% in productivity, yet this remains lower compared to many high-performing states.
- Mixed cropping is a common practice among betel nut farmers in the state—50% of the farmers grow betel nut along with betel leaf, while 36% combine it with paddy, indicating diversified land use.

- Importantly, 84% of the betel nut growers in Assam are smallholders, cultivating on plots smaller than 2 bighas (about 0.66 acres). This fragmentation of landholdings limits economies of scale and likely contributes to lower productivity.
- Production Trends despite year-on-year production increases, pest attacks (squirrels, monkeys) have significantly reduced yields in recent years, posing a major challenge.
- Productivity factors effected by positive influence and negative influence.

Positive Influences were

  - More Trees: Increasing the number of trees can lead to higher productivity.
  - Larger Land Area: Expanding the land area under betel nut cultivation can boost output.
  - Education: Educated farmers are more likely to adopt best practices, leading to improved productivity.
  - Household Labor: Availability of household labor can contribute to better farm management and higher productivity.

Negative Influences were

  - Older Farmers: Older farmers may experience reduced productivity due to physical limitations or slower adoption of new techniques.
  - Excessive Manure Costs: High input costs, particularly manure, can reduce efficiency and profitability.

### 5.2.2 Objective 2: To Estimate Technical Efficiency and Its Determinants of Betel Nut Production

This objective was addressed using the Stochastic Frontier Production Function (SFPF) approach, estimated through FRONTIER 4.1 software with a trans-log functional form. The goal was to measure how efficiently betel nut farmers utilize their resources, and to identify factors that influence efficiency levels.

- Technical inefficiency is the dominant cause of low productivity: The analysis shows that the majority of the output shortfall is due to inefficiency in resource use, not due to uncontrollable factors like weather or pests.The inefficiency variance component ($\sigma^2_u$) is statistically significant, while the random error component ($\sigma^2_v$) is negligible.

- Number of Trees per Hectare: Positively and significantly affects output. Increasing tree density boosts productivity.
- Manure Cost: Negatively affects productivity when overused, indicating diminishing returns due to inefficient input use.
- Age of Farmer: Older farmers tend to be less productive, possibly due to reduced physical capacity and less adaptability to new practices.
- Education Level: Strongly enhances productivity. Educated farmers are more efficient, likely due to better decision-making and awareness.
- Area Under Cultivation: Significantly increases output. Larger land holdings support higher production.
- Household Size: Positively related to productivity, Indicates that larger households contribute more family labor, which supports better farm operations
- Experience: Surprisingly, experience had a negative or insignificant effect, possibly due to continued reliance on traditional methods.

Efficiency ratios and variance analysis

- Lambda ($\lambda$) value is extremely high, confirming that inefficiency is the main source of variation in output, not random shocks.
- Suggests ample scope for improving performance through better practices, input optimization, and training.

### 5.2.3 Objective 3: To identify the problems faced by Betel nut growers

- Pest Infestation Challenges: One of the most frequently cited problems by betel nut growers was crop damage caused by pests, particularly squirrels and monkeys. These pest attacks led to significant yield losses across multiple years (2022–2024). Despite betel nut being a low-maintenance crop, the absence of effective and affordable pest control measures has contributed to a steady decline in output. This underscores the need for community-driven or institutionalized integrated pest management practices.

- Input Management Issues: The regression analysis revealed a negative coefficient for manure costs (-0.00174), indicating diminishing returns with increased expenditure. This finding suggests that many farmers are not optimizing their input use, leading to inefficiencies. Over-application of manure or improper resource allocation may reduce rather than enhance productivity. Hence, there is a pressing need to introduce scientific input use training and cost-effective input strategies tailored to smallholder conditions.
- Aging Farmer Population: The average age of betel nut cultivators in the study was approximately 51 years. A clear negative correlation between age and productivity (-7.6%) was observed, reflecting the physical limitations, slower decision-making, and reduced adaptability to new technologies among older farmers. This demographic trend emphasizes the necessity of involving younger household members in farm operations and promoting youth engagement in agriculture through targeted schemes and incentives.
- Land Constraints: Approximately 84% of the surveyed farmers cultivate betel nut on 2 bighas or less, classifying them as marginal or smallholders. Although the cultivated area shows a strong positive association with productivity, land fragmentation limits the potential for scaling up. Many growers adopt mixed cropping systems (50% cultivate betel leaf alongside betel nut) as a risk diversification strategy. However, land constraints continue to pose a structural barrier to expansion and mechanization.
- Knowledge Gaps: The educational profile of the farmers revealed a low average of just 3.84 years of formal schooling. Limited educational attainment restricts their access to modern agricultural knowledge and techniques. Furthermore, despite many farmers possessing years of experience, the analysis showed a negative coefficient for experience, suggesting that reliance on traditional practices may inhibit innovation and efficiency. This highlights the importance of capacity-building programs, extension services, and targeted training modules to bridge knowledge gaps.
- Economic Pressures: The growers in the study experienced high income variability, with annual earnings ranging between ₹1 to ₹2.5 lakhs. Rising input costs, especially for manure and labor, are exerting financial pressure and reducing net returns. Furthermore, due to the homestead nature of many plantations, access to structured markets remains limited, affecting price realization. These findings point toward a need for improved market linkages, value chain integration, and supportive price policies.

## 5.3 Overall Findings

This study provides a holistic examination of betel nut cultivation in Assam's Nagaon district, revealing several critical insights about production systems, efficiency determinants, and socioeconomic challenges. The research demonstrates that while betel nut farming serves as a vital economic activity for smallholder farmers, multiple interrelated factors constrain its full potential.The analysis of 50 sample growers shows a predominantly small-scale farming structure, with 84% cultivating less than 2 bigha of land. These farmers achieve relatively high technical efficiency (average score of 0.90), suggesting competent resource management, yet a 9% improvement potential remains untapped. The stochastic frontier analysis particularly highlights that inefficiencies in farm management - not external shocks - account for nearly all output variability ($\sigma_u$=2.41 vs $\sigma_v \approx 0$).

Key productivity drivers include land area (showing 5.96% output increase per unit expansion) and farmer education (27% efficiency gain per additional schooling year). However, counterproductive factors emerge, including an aging farmer population (average age 51 years) showing 7.6% annual efficiency decline, and excessive input costs yielding diminishing returns. The prevalent mixed cropping systems (50% with betel leaf) demonstrate farmers' adaptive strategies to mitigate risks.

Critical challenges identified include severe pest damage (from squirrels/monkeys), land fragmentation limiting economies of scale, and low education levels (average 3.84 years) hindering modern technique adoption. These constraints manifest in variable annual yields (520-2,650 kg/farmer) despite the crop's general profitability.

These findings collectively suggest that targeted interventions in farmer education, integrated pest management, and land consolidation could substantially enhance productivity. The study underscores that betel nut cultivation's sustainability hinges on addressing both agronomic constraints and the demographic transition toward an aging farming population, providing actionable insights for policymakers aiming to strengthen this important rural livelihood.

## 5.4 Policy Implications

1. Education & Training Programs-

- Many farmers in the region have low levels of formal education, limiting their adoption of modern techniques.
- Policy should focus on developing structured farmer education programs to improve technical knowledge.
- Establishing vocational training and farmer field schools can enhance hands-on learning and skill development in improved betel nut cultivation practices.

2. Pest Management Solutions

- Squirrels, monkeys, and other pests significantly damage crops.
- Policies should promote community-based pest control mechanisms and subsidize eco-friendly pest control products.
- Research institutions should be encouraged to develop localized, betel nut-specific pest management technologies.

3. Land Consolidation & Resource Optimization

- With 84% of farmers operating on small landholdings, fragmentation reduces economies of scale.
- Promotion of cooperative or cluster farming models can help achieve better resource use and higher efficiency.
- Land pooling schemes should be introduced to make mechanization and extension support more viable.

4. Input Cost Management

- High input costs (e.g., manure, fertilizer) are not always associated with higher productivity.
- Subsidies for organic or locally available inputs can help reduce dependency on costly external inputs.

- Input cooperatives can enable bulk purchasing and distribution, while guidelines on optimal input use will improve cost efficiency.

5. Youth Engagement & Succession Planning

- The farming population is aging, with limited youth involvement in agriculture.
- Tailored programs such as agri-entrepreneurship training and start-up grants can attract youth.
- Mentorship between older and younger farmers can ensure knowledge transfer and smooth generational succession.

6. Market Linkages & Value Addition

- Limited market access and value addition opportunities reduce farmer income.
- Strengthening local-level processing units and promoting Farmer Producer Organizations (FPOs) can improve bargaining power and profitability.
- Quality certification schemes can help farmers fetch premium prices by targeting organized markets.

7. Research & Development (R&D)

- There is a need for varietal improvement suited to the local agro-climatic conditions.
- Investment in R&D should also prioritize climate-resilient farming practices.
- Stronger linkages between research institutes and farmers through extension services will ensure better dissemination of innovations.

8. Financial Support Mechanisms

- Access to affordable and crop-specific credit remains limited.
- Introducing customized credit schemes with flexible terms will ease financial constraints.
- Crop insurance products should be introduced to protect against pest attacks and climate shocks, alongside a price risk stabilization fund to handle market volatility.

### 5.5 Conclusions

The study on betel nut cultivation in Nagaon district, Assam, highlights its economic significance for small and marginal farmers. While the sector shows high technical efficiency (90%), challenges such as pest infestations, aging farmers, and high input costs limit productivity. Mixed cropping systems, particularly betel nut with betel leaf or paddy, enhance income stability. However, the dominance of small landholdings and reliance on traditional practices indicate a need for modernization. Key recommendations include improved pest management, farmer training programs, financial support, and greater involvement of younger, educated farmers. Addressing these factors can further strengthen betel nut cultivation as a sustainable livelihood option in the region.

The analysis of technical efficiency using the Stochastic Frontier Production Function revealed that there exists a considerable level of inefficiency among betel nut growers in Assam. The variation in output is largely explained by technical inefficiency, rather than random external factors. Key factors influencing efficiency include education, land area, household size (positive impact), and age, experience, and high input costs (negative impact). Educated farmers with larger operational areas and sufficient household labor showed higher productivity, while aging farmers and inefficient input use lowered efficiency. Overall, the study indicates significant scope for improving output by enhancing efficiency through better resource management, training, and modern practices. While natural conditions are generally favorable, inefficient farming practices are holding back productivity. By improving farmers' skills, modernizing cultivation methods, and ensuring better input management, technical efficiency can be significantly improved, leading to higher income and sustainable betel nut farming in Assam.

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## APPENDIX I

## Questionnaire

**Topic: Technical Efficiency of Betel nut growers of Assam, India: A study in Nagaon District**

1. Name of the Respondent: …………………………………………………
2. Name of the Village: ……………………………………………………
3. Name of the Panchayat: …………………………………………………
4. Block: ……………………………………………………………………..

### Details of the Household:

1. Religion:

Hinduism ☐ Islam ☐ Christianity ☐

Sikhism ☐ Jainism ☐ Buddhism ☐

Other ☐

2. Caste

S.T. ☐ S.C. ☐ O.B.C. ☐

M.O.B.C. ☐ General ☐

3. Marital Status:

Single ☐ Married ☐

4. Type of the family: Joint ☐ Nuclear ☐

5. Number of family members (in number):

Male ☐ Female ☐ Total ☐

6. (a) House Type:

Pucca Semi Pucca ☐ Kutcha ☐

(b) Type of Sanitation: Pucca [ ] Kutcha [ ] Open space [ ]

(c) Type of cooking fuel: Gas [ ] Wood [ ] Both Gas and wood [ ]

Other [ ]

(d) Type of drinking water: Pipe water [ ] Tube well [ ] Rainwater [ ]

Tanker-truck [ ] Bottled water [ ] Other [ ]

(e) Lighting source: Electricity [ ] Kerosene [ ] Solar [ ] Other [ ]

(f) Assets holding:

| Assets | Quantity (No.s) | Current Value (in Rs.) |
|---|---|---|
| TV | | |
| Laptop | | |
| Mobile Phone | | |
| Bye cycle | | |
| Two-wheeler | | |
| Four-wheeler | | |
| Refrigerator | | |
| Air-conditioner | | |
| Radio | | |
| Other | | |
| Total | | |

7. (a) Details of the family members:

| Sl. No. | Age | Sex (M/F) | Relation with respondent (Code) | Educational Status (Code) | Occupational Status (Code) |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

**Code details:**

**Relation with respondent**: Self(1), Spouse(2), Son(3), Daughter(4), Father(5),

Mother(6), Grand F(7), Grand M(8), Other(9)

**Educational status**: Child(0), Illiterate(1), Read up to primary school level(2), Read up to middle school level(3), Read up to HSLC level(4), Read up to HS level(5), Read up to Graduate Level(6), Post Graduate(7), M.Phil and Ph.D(8), Others(9)

**Occupational status:** Agri & allied activity (1), Industry(2), Service (3), House wife (4), Student (5)

8. Monthly income of household (in Rs.)

| **No. of person** | **Service** | **Agriculture and allied** | **Betel Nut** | **Other** | **Total** |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

9. Monthly Expenditure Pattern of household:

| **Item** | **Expenditure (in Rs.)** |
|---|---|
| Food | |
| Clothings | |
| Cooling Fuel | |
| Health | |
| Children's Education | |
| Electricity Bill | |
| Telephone Bill | |
| Other | |
| Total | |

**Details about Betel Nut Cultivation:**

**10.** Total land holding:…………………………………………………………..(in Bigha)

**11.** Area under Betel nut Cultivation:

| **Size of the garden (in Katha or Bigha)** | **Total area under betel nut cultivation** |
|---|---|
| **1-2 katha** | |
| **3-4 katha** | |
| **1-2bigha** | |
| **Above 2 bigha** | |

**12.** Are you producing betel nut with betel leaf or others (mixed cropping):

(Yes/No)

13. If yes, area under mixed cropping:……………………………………………(in Bigha, Katha)

14. How much time do you need for growing a betel nut tree till it yields: ……………..

(In month)

15. Area under crop cultivation:

| Sl No. | Crops | Area (bigha, katha) |
|---|---|---|
| 1 | Paddy | |
| 2 | Vegetables | |
| 3 | Other | |

16. Pattern of Land (Bigha):

Own Land ☐ Leased Land ☐ Irrigated ☐ Not irrigated ☐

17. Source of Credit in 2023-24:

| **Source** | **Fixed Capital (Rs.)** | **Working Capital (Rs.)** | **Total (Rs.)** |
|---|---|---|---|
| Self | | | |
| Family | | | |
| Financial Institution | | | |
| Money Lender | | | |
| Other | | | |

18. Total Fixed Cost:

| **Sl No.** | **Item** | **Quantity** | **Annual Expenditure (Rs.)** |
|---|---|---|---|
| 1 | Land Development Cost | | |
| 2 | Cost of betel nut plants | | |
| 3 | Bore well, Pump set | | |
| Total (A) | | | |

19. Total Variable Cost:

| Sl No. | Item | Quantity | Annual Expenditure (Rs.) |
|---|---|---|---|
| 1 | Land Revenue | | |
| 2 | Chemical Fertilizer | | |
| 3 | Fungicide | | |
| 4 | Lime, calcium & curry | | |
| 5 | Transportation Cost | | |
| 6 | Labour cost | | |
| 7 | Harvesting cost | | |
| 8 | Manures | | |
| Total (B) | | | |

20. Total Cost = Tota (A) + Total(B) = ............................................................(Rs.)

21. Average yield of Betel nut (kg)/tree: ……………………………………………

22. Total Yield of Betel nut in terms of dry cured nuts in last three years:

| Year | Quantity (Kg) | Quantity sold (Kg) | Price/Kg (Rs.) | Total Revenue (Rs.) |
|---|---|---|---|---|
| 2022 | | | | |
| 2023 | | | | |
| 2024 | | | | |

23. Annual Production, Annual Average Price and Annual Average Income from Betel Nuts:

| Year | Quantity (Kg) | Quantity sold (Kg) | Average Price/Kg (Rs.) | Annual Average Income(Rs.) |
|---|---|---|---|---|
| 2021-22 | | | | |
| 2022-23 | | | | |
| 2023-24 | | | | |

24. Employment Generation (2023-24):

| | **Permanent** | | **Casual** | |
|---|---|---|---|---|
| | Family Member | Hired | Family Member | Hired |
| | | | | |
| | | | | |
| Total | | | | |

**Marketing of Betel Nut:**

25. For what purpose betel nuts are produced:

Supari ☐ Colour production ☐ Home use ☐ other ☐

26. What the extent of market of your product?

Local ☐ Throughout the district ☐ Throughout the country ☐

Throughout the state ☐ Export to foreign countries ☐

27. Name the countries where betel nuts are exported

| Year | Country | Quantity (Kg) | Price/Kg (Rs.) |
|---|---|---|---|
| 2021-22 | | | |
| 2022-23 | | | |
| 2023-24 | | | |
| Total | | | |

28. How do you sell your product?

Direct ☐ Through intermediaries ☐ Through e-commerce ☐

**Details about Problems Experienced by the Betel Nut Growers:**

29. What are the problems in marketing your product?

| Problems | Strongly Agree | Agree | NA-N-DA | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Low Demand | | | | | |
| Low Price | | | | | |
| High Transportation Cost | | | | | |
| Availability of substitute product | | | | | |
| Lack of regulated market | | | | | |
| Did not get the minimum price from middlemen | | | | | |

30. Other problems that you are faced in betel nut cultivation?

| **Problems** | **Strongly Agree** | **Agree** | **NA-N-DA** | **Disagree** | **Strongly Disagree** |
|---|---|---|---|---|---|
| Financial | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| Non availability of skilled labour | | | | | |
| Shortage of water | | | | | |
| Load shading | | | | | |
| Insufficient organic manures | | | | | |
| High cost of organic manures | | | | | |
| Lack of knowledge about pest and disease | | | | | |
| Possibility of affected by disease | | | | | |
| Loss due to animal attack | | | | | |
| Lack of storage facility | | | | | |
| Affected by smuggled betel nuts from Myanmar | | | | | |

31. View from respondent about betel nut cultivation:

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**ANNEXURE**


GPS Map Camera
Uttar Gamari Ati, Assam, India
101, Kandoli Rd, Uttar Gamari Ati, Assam 782144, India
Lat 26.262545° Long 92.731562°
04/05/2025 11:16 AM GMT +05:30
Google


GPS Map Camera
Uttar Gamari Ati, Assam, India
101, Kandoli Rd, Uttar Gamari Ati, Assam 782144, India
Lat 26.262868° Long 92.731385°
04/05/2025 11:23 AM GMT +05:30
Google