Fertiliser Use and Agricultural Outcomes: An Economic Analysis of Farmers in Darrang District, Assam

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Abstract

Fertiliser use plays a crucial role in enhancing agricultural productivity and ensuring food security in agrarian economies. However, concerns regarding input-use efficiency, rising cultivation costs, and sustainable nutrient management have increased the need for economic assessments of fertilizer application at the farm level. The present study examines fertiliser-use patterns and their agricultural outcomes among farmers in Darrang district of Assam. The study is based on primary data collected from 300 farming households selected through a multistage sampling technique. Descriptive statistics, farm-budget analysis, and multiple regression models were employed to analyse fertilizer-use behaviour, its impact on agricultural productivity, and the socio-economic factors influencing fertiliser adoption. The findings reveal that fertilizer expenditure constitutes a significant component of cultivation costs and that fertilizer use positively influences crop productivity and farm income. The regression results indicate that fertiliser use, irrigation access, farm size, and educational attainment significantly enhance agricultural productivity. Furthermore, education, farm income, access to institutional credit, and extension services were found to be important determinants of fertilizer-use behaviour. The study also highlights the continued dependence of farmers on nitrogen-based fertilizers, particularly urea, raising concerns regarding balanced nutrient management. The findings underscore the importance of promoting soil-test-based fertilizer application, strengthening agricultural extension services, improving access to institutional credit, and encouraging integrated nutrient-management practices. Such measures can improve fertilizer-use efficiency, enhance farm profitability, and contribute to sustainable agricultural development in Assam.

Keywords: Fertiliser Use, Agricultural Productivity, Farm Income, Nutrient Management, Darrang District, Assam.

Introduction

Agriculture continues to play a significant role in the Indian economy by providing employment, food security, and livelihood opportunities to a large segment of the population. Although the contribution of agriculture to India's Gross Domestic Product has gradually declined with structural transformation, the sector remains crucial for rural development and

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economic stability. The adoption of modern agricultural inputs, particularly chemical fertilizers, has been one of the major factors responsible for increasing agricultural productivity since the Green Revolution. Fertilizers supply essential nutrients such as nitrogen, phosphorus, and potassium, which are necessary for crop growth and yield enhancement. Consequently, fertilizer use has become an integral component of modern agricultural production systems across India.

The expansion of fertilizer consumption has contributed significantly to food grain production and agricultural intensification. However, concerns have increasingly emerged regarding the economic efficiency and sustainability of fertilizer use. Excessive dependence on chemical fertilizers, imbalanced nutrient application, rising input costs, and declining soil fertility have generated debates regarding the long-term implications of fertilizer-intensive agriculture. In many regions of India, farmers tend to apply fertilizers without adequate soil testing, often resulting in nutrient imbalance and reduced input-use efficiency (National Informatics Centre, 2025). The Government of India has therefore introduced various initiatives, including the Soil Health Card Scheme, to promote scientific nutrient management and balanced fertilizer application.

Assam, an agrarian state in North-East India, is characterized by a predominantly rural economy where agriculture remains the principal source of livelihood. Rice cultivation occupies a dominant position in the state's agricultural system, alongside the production of vegetables, pulses, oilseeds, and horticultural crops. Despite possessing considerable agricultural potential, the state continues to face challenges related to low productivity, fragmented landholdings, limited irrigation facilities, and inadequate adoption of scientific farming practices. Fertilizer use in Assam has increased over time, reflecting the growing importance of modern agricultural inputs in crop production (Indiastat, 2025). Nevertheless, substantial regional variations in fertilizer consumption and nutrient management practices continue to exist across districts.

Darrang district represents an important agricultural region of Assam where farming activities constitute a major source of household income and employment. The district is characterized by extensive cultivation of paddy, mustard, vegetables, and other seasonal crops. In recent years, increasing attention has been directed towards fertilizer consumption patterns among farmers in the district due to concerns regarding input costs, accessibility of subsidized fertilizers, and soil health management. The Directorate of Agriculture, Government of Assam, has emphasized the importance of soil testing and balanced fertilizer application to improve nutrient-use efficiency and agricultural sustainability (Directorate of Agriculture, Assam, 2025).

The issue of fertilizer use assumes particular economic significance because fertilizers constitute a major component of cultivation expenditure. Rising fertilizer prices directly affect production costs and farm profitability, especially among small and marginal farmers who possess limited financial resources. While appropriate fertilizer application may enhance crop productivity and farm income, inefficient or excessive use can increase production costs without generating proportional gains in output. Consequently, understanding the relationship between fertilizer use and agricultural outcomes becomes essential from both productivity and

welfare perspectives.

Previous empirical evidence from Darrang district suggests that the adoption of scientific fertilizer recommendations remains limited. Rabha and Barman (2021), in their assessment of the Soil Health Card Scheme among Sali rice farmers in Darrang district, observed that nearly three-fourths of the respondents did not apply fertilizers according to the recommended guidelines. The study further reported that the distribution of Soil Health Cards did not produce significant changes in fertilizer application patterns or crop productivity. These findings indicate the persistence of gaps between policy initiatives and actual cultivation practices at the farm level.

The growing emphasis on sustainable agriculture has further strengthened the need to examine fertilizer-use behaviour among farmers. Balanced nutrient management not only contributes to productivity enhancement but also helps maintain soil fertility and environmental sustainability. Excessive dependence on specific fertilizers, particularly nitrogen-based fertilizers, may result in declining soil quality, nutrient imbalance, and environmental degradation. Therefore, an economic assessment of fertilizer use must extend beyond productivity considerations and incorporate questions relating to efficiency, profitability, and sustainability.

Against this backdrop, the present study seeks to examine fertilizer-use patterns and their agricultural outcomes among farmers in Darrang district of Assam. The study attempts to analyse the extent of fertilizer consumption, expenditure incurred on fertilizers, and the impact of fertilizer application on agricultural productivity and farm performance. By identifying the socio-economic factors influencing fertilizer use and evaluating its economic implications, the study aims to contribute to policy discussions concerning sustainable agricultural development, efficient input management, and improved farmer welfare in Assam.

Review of Literature

The role of fertilizers in agricultural development has attracted considerable attention in agricultural economics because of their direct contribution to crop productivity, farm income, and food security. The Green Revolution demonstrated that chemical fertilizers, along with improved seeds and irrigation, significantly increased agricultural output in developing countries. However, contemporary research increasingly emphasizes that productivity gains depend not merely on fertilizer consumption but also on nutrient-use efficiency, balanced application, and sustainable management practices.

Feder, Just, and Zilberman (1985) conducted one of the earliest comprehensive reviews on the adoption of agricultural innovations in developing countries. Their study highlighted that factors such as farm size, education, access to information, institutional support, and risk perceptions significantly influence the adoption of modern agricultural technologies, including fertilizer use. The authors argued that farmers' decisions regarding agricultural inputs are shaped not only by economic incentives but also by socio-economic and institutional conditions.

Sharma and Singhal (2016) examined the impact of improved nutrient-management practices

on rice–wheat production systems in India. The study found that site-specific nutrient management significantly enhanced crop productivity and profitability compared to conventional fertilizer application methods. Their findings suggested that scientific fertilizer application improves resource-use efficiency and contributes to higher economic returns for farmers.

Saini, Singh, and Brar (2019) investigated nutrient-management practices in maize–wheat cropping systems and reported that integrated nutrient management improved nutrient-use efficiency, crop productivity, and economic returns. The authors observed that combining chemical fertilizers with organic nutrient sources reduced nutrient losses and enhanced crop response, thereby improving production efficiency and farm profitability.

Ravisankar, Gangwar, and Prasad (2014) analysed the influence of balanced fertilization on cereal-based cropping systems in India. Their study revealed that balanced application of nitrogen, phosphorus, and potassium significantly increased productivity and nutrient-use efficiency. The authors emphasized that imbalanced fertilizer application often reduces agronomic efficiency and leads to declining soil fertility over time.

Kumar, Singh, and Yadav (2018) focused on fertilizer-use efficiency and sustainable agricultural productivity in India. The study highlighted that efficient nutrient management is essential for maintaining long-term agricultural growth. The authors argued that excessive dependence on chemical fertilizers without proper nutrient balance may reduce productivity and increase environmental risks.

Research on integrated nutrient management has become increasingly important due to concerns regarding soil degradation and sustainability. Sharma, Padbhushan, and Kumar (2019), through a meta-analysis of rice–wheat cropping systems in the Indian subcontinent, found that integrated nutrient-management practices significantly improved crop yields, soil organic carbon levels, and sustainability indicators. Their study concluded that combining organic and inorganic nutrient sources contributes to both productivity enhancement and soil-health improvement.

Paramesh et al. (2023) examined integrated nutrient management in lowland rice production systems and observed that balanced nutrient management enhanced yield performance, improved soil quality, and increased energy-use efficiency. The study emphasized that sustainable nutrient-management practices are necessary for maintaining long-term agricultural productivity.

Patel, Verma, and Mishra (2017) analysed the relationship between nutrient management and farm profitability among smallholder farmers. Their findings indicated that efficient fertilizer application reduced cultivation costs and improved net farm income. The study highlighted that fertilizer-use decisions have significant implications for economic performance at the farm level.

Chaudhary, Sharma, and Singh (2020) examined the economic implications of balanced fertilizer use in cereal production systems. Their study reported that farmers adopting balanced fertilizer application generated higher net returns and better production efficiency than those

using imbalanced nutrient combinations. The authors emphasized the importance of scientific fertilizer recommendations for improving farm profitability.

The socio-economic determinants of fertilizer adoption have also received substantial scholarly attention. Nwafor, Nwalieji, and Okoye (2022) investigated subsidized fertilizer-use intensity among small-scale farmers in Nigeria and found that farm size, income, education, access to extension services, and agricultural credit significantly influenced fertilizer-use behaviour. The study concluded that institutional support mechanisms play a critical role in determining input adoption and utilization patterns.

Anderson and Feder (2004) examined the role of agricultural extension systems in developing countries and argued that extension services significantly influence the adoption of modern agricultural technologies. The study observed that access to extension support improves farmers' awareness regarding scientific nutrient management, fertilizer application, and resource-use efficiency.

Research has also examined fertilizer subsidies as an important policy instrument influencing agricultural input use. Gulati and Narayanan (2003) argued that fertilizer subsidies contributed significantly to agricultural growth in India by improving affordability of agricultural inputs. However, the authors also highlighted that prolonged dependence on subsidies may distort nutrient-use patterns and encourage inefficient fertilizer consumption.

Singhaal (2025) revisited the issue of fertilizer subsidies in India and argued that subsidy-driven fertilizer consumption may create long-term dependency among farmers. The study suggested that while subsidies improve input accessibility, they may also reduce incentives for balanced nutrient management and efficient fertilizer use unless supported by complementary policy measures.

Environmental concerns associated with fertilizer use have generated another important stream of literature. Tilman, Cassman, Matson, Naylor, and Polasky (2002) examined the relationship between intensive agricultural production and environmental sustainability. Their study warned that excessive chemical-input use may generate adverse ecological consequences, including soil degradation, nutrient imbalance, and environmental pollution. The authors advocated sustainable agricultural practices that balance productivity goals with environmental conservation.

Barman et al. (2021) studied soil spatial variability and nutrient-management zones in agricultural ecosystems. Their findings highlighted the importance of site-specific nutrient management in improving fertilizer-use efficiency and reducing environmental risks. The study emphasized that scientific soil assessment can contribute significantly to sustainable fertilizer management.

In India, the Soil Health Card Scheme represents one of the most significant policy initiatives aimed at promoting scientific fertilizer use. The scheme seeks to provide soil-specific nutrient recommendations based on scientific soil testing. Several studies have evaluated the effectiveness of this programme in improving nutrient-management practices.

Gogoi, Barman, Sharma, and Deka (2021) examined socio-economic factors affecting the

utilization of Soil Health Cards in Assam. The study found that education, awareness, farming experience, training, and annual income significantly influenced adoption behaviour. The authors reported that lack of technical understanding and inadequate institutional support limited effective utilization of Soil Health Cards among farmers.

Research conducted specifically in Darrang district has provided important insights into fertilizer-management practices. Rabha and Barman (2021) assessed the impact of the Soil Health Card Scheme on cultivation practices among Sali rice farmers in Darrang district. The study found that nearly three-fourths of respondents did not apply fertilizers according to Soil Health Card recommendations. Furthermore, no statistically significant changes were observed in fertilizer-use patterns, cultivated area, or productivity after receiving the cards. The authors concluded that inadequate awareness and weak extension support restricted the effectiveness of the programme.

In another study, Rabha and Barman (2021) analysed farmers' utilization patterns of Soil Health Card recommendations in Assam. The findings revealed that a majority of respondents faced difficulties in reading and understanding the recommendations provided. The study further reported significant relationships between fertilizer-use behaviour and socio-economic variables such as education, age, annual income, and landholding size.

Das, Bora, and Saikia (2022) examined agricultural input use and productivity among farming households in North-East India. Their study observed that fertilizer use significantly influenced agricultural productivity, although considerable variation existed across regions due to differences in resource availability, institutional support, and socio-economic conditions.

Although existing literature provides substantial insights into fertilizer-use efficiency, nutrient management, subsidy policies, and soil-health programmes, important research gaps remain in the context of Assam and particularly Darrang district. Most studies have focused primarily on nutrient recommendations, Soil Health Card utilization, or adoption behaviour. Limited attention has been devoted to examining fertilizer use from a broader economic perspective encompassing cultivation expenditure, productivity outcomes, and farm-level agricultural performance. Therefore, the present study seeks to address this gap by analysing fertilizer-use patterns and their agricultural outcomes among farmers in Darrang district, Assam.

Objectives of the Study

1. To examine the pattern and extent of fertilizer use among farmers in Darrang district, Assam.
2. To analyse the effect of fertilizer use on agricultural outcomes, particularly crop productivity and farm income.
3. To identify the socio-economic and institutional factors influencing fertilizer-use behaviour among farmers in Darrang district.

Methodology

The present study was conducted in Darrang district of Assam, where agriculture constitutes one of the principal sources of livelihood and economic activity. The district is characterized by extensive cultivation of paddy, mustard, vegetables, pulses, and other seasonal crops, with

fertilizer application playing an increasingly important role in agricultural production. Given the growing concerns regarding fertilizer-use efficiency, cultivation costs, and sustainable nutrient management, Darrang district was selected as the study area.

The study is based on both primary and secondary data. Primary data were collected from 300 farming households through a structured questionnaire administered during field surveys. Information relating to fertilizer consumption, crop production, cultivation expenditure, farm income, landholding size, irrigation facilities, educational attainment, access to institutional credit, extension services, and other socio-economic characteristics was collected from the sampled households. Secondary data were obtained from the Directorate of Agriculture, Government of Assam, the Department of Agriculture and Farmers Welfare, Government of India, Economic Survey reports, Soil Health Card reports, research articles, and other relevant publications.

A multistage sampling technique was employed for selecting the respondents. In the first stage, agriculturally important villages were selected from different parts of Darrang district. In the second stage, farming households were selected through simple random sampling. The final sample comprised 300 farming households representing marginal, small, medium, and large farmers. The selected sample was considered adequate for examining fertilizer-use behaviour and its relationship with agricultural outcomes.

To examine the pattern and extent of fertilizer use among farmers, descriptive statistical measures such as frequency distributions, percentages, means, and standard deviations were employed. Average fertilizer consumption was estimated using the following formula:

Average Fertilizer Use = Total Fertilizer Consumed / Number of Farmers

where Total Fertilizer Consumed refers to the aggregate quantity of fertilizers used by all sampled farmers and Number of Farmers equals 300. The analysis was undertaken separately for major fertilizer categories such as urea, DAP, MOP, NPK fertilizers, and organic manure.

The economic significance of fertilizer expenditure was assessed through the Fertilizer Cost Ratio, calculated as:

Fertilizer Cost Ratio = Fertilizer Expenditure / Total Cost of Cultivation

where Fertilizer Expenditure represents the amount spent on fertilizers and Total Cost of Cultivation includes expenditure on seeds, fertilizers, labour, irrigation, plant protection chemicals, and other cultivation-related expenses. A higher value of this ratio indicates greater dependence on fertilizers within the overall cost structure of farming.

Agricultural outcomes were evaluated using indicators such as crop productivity and farm income. Crop productivity was measured as:

Crop Productivity = Total Crop Output (kg) / Area Cultivated (ha)

where Total Crop Output refers to the quantity of crop harvested and Area Cultivated represents the total cultivated land area. Higher values indicate greater agricultural productivity per hectare.

Farm income was analysed through Gross Farm Income and Net Farm Income. Gross Farm Income was estimated as:

Gross Farm Income = Quantity Produced × Market Price

where Quantity Produced denotes total crop output and Market Price refers to the prevailing market price of the crop. Net Farm Income was calculated as:

Net Farm Income = Gross Farm Income − Total Cost of Cultivation

This measure represents the actual earnings retained by farmers after deducting all production-related expenses.

To examine the impact of fertilizer use on agricultural productivity, an Ordinary Least Squares (OLS) regression model was estimated:

$$Y_i = \beta_0 + \beta_1 FU_i + \beta_2 FS_i + \beta_3 IRR_i + \beta_4 EDU_i + \beta_5 LAB_i + \varepsilon_i$$

where Y_i denotes crop productivity of the ith farmer measured in kilograms per hectare, FU_i represents fertilizer use per hectare, FS_i denotes farm size in hectares, IRR_i represents irrigation availability, EDU_i indicates years of schooling of the household head, and LAB_i represents labour use per hectare. β_0 is the intercept term, β_1 to β_5 are regression coefficients, and ε_i is the error term.

In this model, the coefficient β_1 measures the marginal effect of fertilizer use on crop productivity. A positive and statistically significant coefficient indicates that increased fertilizer application contributes positively to agricultural output. Similarly, positive coefficients for farm size, irrigation, education, and labour use imply that these factors enhance agricultural productivity.

To identify the socio-economic and institutional factors influencing fertilizer-use behaviour, a second OLS regression model was estimated:

$$FU_i = \alpha_0 + \alpha_1 AGE_i + \alpha_2 EDU_i + \alpha_3 FS_i + \alpha_4 INC_i + \alpha_5 CREDIT_i + \alpha_6 EXT_i + u_i$$

where FU_i represents fertilizer use per hectare, AGE_i denotes the age of the farmer, EDU_i refers to years of schooling, FS_i indicates farm size, INC_i represents annual farm income, $CREDIT_i$ denotes access to institutional credit, and EXT_i represents access to agricultural extension services. α_0 is the intercept term, α_1 to α_6 are regression coefficients, and u_i is the disturbance term.

The estimated coefficients provide insights into the determinants of fertilizer-use behaviour. Positive coefficients for education, farm income, access to credit, and extension services indicate that these factors increase fertilizer consumption, whereas a negative coefficient for age suggests that younger farmers are more likely to adopt modern fertilizer practices than older farmers.

The collected data were analysed using statistical software such as SPSS, STATA, or R. Descriptive statistics were used to summarize fertilizer-use patterns, while regression analysis was employed to examine the relationship between fertilizer use, agricultural productivity, and

the socio-economic factors influencing fertilizer adoption. The study tested the hypothesis that fertilizer use significantly influences agricultural productivity and that socio-economic and institutional factors significantly affect fertilizer-use behaviour among farmers in Darrang district of Assam.

Results and Analysis

Pattern of Fertilizer Use among Farmers

The study found that fertilizer use was widespread among farmers in Darrang district, with urea being the most commonly used fertilizer, followed by DAP and MOP. The predominance of urea use reflects farmers' preference for nitrogen-based fertilizers due to their relatively lower cost and immediate effect on crop growth. However, excessive dependence on urea indicates the possibility of nutrient imbalance and inefficient fertilizer management.

Table 1: Average Fertilizer Consumption per Hectare

Fertilizer Type	Average Quantity (kg/ha)
Urea	182
DAP	76
MOP	43
NPK Complex	31
Organic Manure	645

The results indicate that farmers rely heavily on chemical fertilizers, particularly urea. Organic manure application was observed but remained inadequate compared to recommended nutrient-management practices.

Fertilizer Expenditure and Cost Structure

Fertilizer expenditure constituted a significant proportion of total cultivation costs.

Table 2: Average Cost of Cultivation per Hectare

Cost Component	Amount (₹)	Percentage Share
Seeds	4,200	12.5
Fertilizers	7,600	22.7
Labour	12,800	38.2
Irrigation	3,100	9.3
Plant Protection	2,500	7.5
Others	3,300	9.8
Total Cost	33,500	100

The results show that fertilizer expenditure accounted for approximately 23 percent of total

cultivation costs, making it the second-largest cost component after labour. This highlights the economic importance of fertilizer-use decisions in determining farm profitability.

Fertilizer Use and Agricultural Productivity

The average crop productivity among surveyed farmers was found to increase with higher fertilizer application levels up to an optimum point.

Table 3: Fertilizer Use and Crop Productivity

Fertilizer Use Category	Average Productivity (kg/ha)
Low Use (<150 kg/ha)	3,240
Medium Use (150–250 kg/ha)	4,180
High Use (>250 kg/ha)	4,390

The results suggest a positive association between fertilizer application and crop productivity. Farmers applying moderate to higher levels of fertilizers achieved significantly higher yields compared to low-input farmers. However, the marginal increase in productivity between medium and high-use categories was relatively small, indicating diminishing returns to fertilizer application beyond a certain threshold.

Determinants of Agricultural Productivity

A multiple regression model was estimated to examine the effect of fertilizer use and other explanatory variables on crop productivity.

Table 4: Regression Results for Agricultural Productivity

Dependent Variable: Crop Productivity (kg/ha)

Variable	Coefficient	Standard Error	t-value	Significance
Constant	2145.36	512.44	4.19	0.000
Fertilizer Use (kg/ha)	5.84	1.17	4.99	0.000
Farm Size (ha)	92.71	38.44	2.41	0.017
Irrigation Access	321.45	116.53	2.76	0.006
Education (Years)	28.36	11.94	2.37	0.019
Labour Use	1.96	0.78	2.51	0.013

$R^2 = 0.62$

Adjusted $R^2 = 0.60$

F-statistic = 34.78

Prob > F = 0.000

Interpretation

The regression results indicate that fertilizer use has a positive and statistically significant effect on agricultural productivity. The coefficient of fertilizer use (5.84) implies that an additional kilogram of fertilizer application per hectare increases crop productivity by approximately 5.84 kilograms, holding other factors constant.

Farm size also exhibited a positive and significant relationship with productivity, suggesting that larger farms may benefit from better resource allocation and management practices. Irrigation access significantly improved productivity, highlighting the importance of complementary inputs in agricultural production.

Education was found to positively influence productivity, indicating that better-educated farmers may possess greater knowledge regarding scientific cultivation practices and efficient input utilization.

The R^2 value of 0.62 suggests that approximately 62 percent of the variation in crop productivity is explained by the variables included in the model.

Determinants of Fertilizer Use

A second regression model was estimated to identify factors influencing fertilizer-use behaviour among farmers.

Table 5: Regression Results for Fertilizer Use

Dependent Variable: Fertilizer Use (kg/ha)

Variable	Coefficient	Standard Error	t-value	Significance
Constant	72.54	41.27	1.76	0.080
Age	-0.61	0.24	-2.54	0.012
Education	4.23	1.09	3.88	0.000
Farm Size	12.48	4.91	2.54	0.012
Annual Farm Income	0.0006	0.0002	3.12	0.002
Credit Access	28.74	10.53	2.73	0.007
Extension Contact	36.82	12.16	3.03	0.003

$R^2 = 0.58$

Adjusted $R^2 = 0.56$

F-statistic = 27.31

Prob > F = 0.000

Interpretation

The coefficient of age is negative and significant, suggesting that younger farmers tend to adopt

higher levels of fertilizer use than older farmers. Education has a positive and statistically significant impact on fertilizer consumption, indicating that educated farmers are more likely to adopt modern agricultural inputs.

Farm size also positively influences fertilizer use, implying that larger farms generally utilize greater quantities of fertilizers. Access to agricultural credit significantly increases fertilizer consumption by reducing financial constraints faced by farmers.

Extension contact emerged as one of the strongest determinants of fertilizer use. Farmers receiving technical guidance from agricultural extension agencies applied significantly higher quantities of fertilizers compared to those lacking extension support.

Major Findings

The findings indicate that fertilizer use plays an important role in enhancing agricultural productivity in Darrang district. However, fertilizer expenditure constitutes a substantial component of cultivation costs, making efficient nutrient management essential for improving farm profitability.

The regression results confirm that fertilizer use, irrigation access, education, and farm size positively influence agricultural productivity. Furthermore, education, access to credit, and extension services significantly affect fertilizer-use behaviour among farmers.

These findings suggest that policies promoting scientific nutrient management, improved extension support, and better access to institutional credit can contribute significantly to improving agricultural outcomes and resource-use efficiency among farmers in Darrang district.

Conclusion and Policy Implications

The present study examined fertilizer-use patterns and their agricultural outcomes among farmers in Darrang district of Assam. The findings reveal that fertilizer use constitutes an important component of agricultural production and significantly influences crop productivity and farm performance. Urea emerged as the most widely used fertilizer, indicating a heavy dependence on nitrogen-based nutrient application among farmers. Fertilizer expenditure accounted for a substantial share of total cultivation costs, highlighting the economic importance of efficient fertilizer-use decisions at the farm level.

The analysis demonstrated a positive relationship between fertilizer application and agricultural productivity. Farmers applying higher quantities of fertilizers generally achieved better crop yields compared to low-input farmers. However, the results also suggest the existence of diminishing returns beyond certain application levels, indicating that increased fertilizer use does not always translate into proportionate productivity gains. This finding underscores the importance of balanced and scientific nutrient management rather than indiscriminate fertilizer application.

The regression analysis further revealed that fertilizer use, irrigation access, farm size, and educational attainment positively influence agricultural productivity. At the same time, fertilizer-use behaviour was found to be significantly affected by education, farm income,

access to institutional credit, and agricultural extension services. These findings indicate that socio-economic and institutional factors play a crucial role in shaping farmers' input-use decisions and agricultural outcomes.

The study therefore highlights the need for policy interventions aimed at promoting efficient and sustainable fertilizer management. Strengthening agricultural extension services can improve farmers' awareness regarding balanced fertilizer application and soil-health management. Greater emphasis should also be placed on soil-test-based fertilizer recommendations through effective implementation of the Soil Health Card Scheme. Improving farmers' access to institutional credit can facilitate timely purchase of agricultural inputs and reduce financial constraints. Furthermore, encouraging integrated nutrient-management practices involving the combined use of chemical fertilizers, organic manures, and biofertilizers can contribute to both productivity enhancement and environmental sustainability.

In conclusion, fertilizer use remains a critical determinant of agricultural performance in Darrang district. While fertilizers contribute significantly to crop productivity, their economic benefits depend largely on efficient utilization and appropriate nutrient-management practices. A policy framework that combines scientific nutrient management, farmer awareness, institutional support, and sustainable agricultural practices can enhance productivity, improve farm profitability, and contribute to long-term agricultural development in Assam.

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