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Farmers buying behaviour towards secondary nutrients fertilizers in southern Tamil Nadu

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Abstract

Secondary nutrient fertilizers (SNFs) play a crucial role in enhancing agricultural productivity in India. These nutrients are important for improving soil health and crop yields; however, their usage is constrained by several challenges. This study aims to identify the factors influencing the purchasing behaviour of farmers towards SNFs in Tamil Nadu. A sample of 120 farmers from four district in southern Tamil Nadu was selected to assess their purchasing behaviour regarding SNFs. The data was analysed using, factor analysis and the relative importance index (RII). The results indicated that interpersonal influence, product satisfaction and experience, branding and marketing efforts, and financial accessibility were the primary factors driving the purchase of SNFs. Conversely, high costs, limited access to credit, and poor soil solubility were identified as major barriers to their usage. Although farmers were generally aware of SNFs, their understanding of the full range of benefits these fertilizers provide for plant growth and soil health was incomplete. The study emphasized the need for increased awareness programs, affordable pricing strategies, and improved access to credit facilities to encourage the broader adoption of SNFs. Such measures could lead to improved leading to farming practices and higher crop yields in Tamil Nadu.

Keywords

buying behaviour; factor analysis; relative importance index; secondary nutrient fertilizers

Introduction

Fertilizers play a critical role in boosting agricultural productivity, particularly in addressing India's growing food demands (1). Essential primary nutrients such as nitrogen, phosphorus, and potassium significantly influence plant growth, crop yields, and quality (2). Given the large population, India's agricultural sector heavily depends on these inputs, making fertilizers essential for modern farming (3).

In addition to primary nutrients, secondary nutrients, collectively known as CMS fertilizers (calcium, magnesium, and sulphur), are equally crucial for maintaining plant health (4). Although required in smaller quantities compared to nitrogen, phosphorus, and potassium, secondary nutrients are essential for plant physiological processes and soil health. Unlike micronutrients such as

boron and molybdenum, secondary nutrients are needed in relatively larger quantities (5, 6). An imbalance whether a deficiency or excess of these nutrients can significantly impact crop production, emphasizing the importance of balanced fertilization strategies (5).

Calcium (Ca) plays an essential role in enhancing crop yields by facilitating vital biological processes such as cell development and metabolism. In acidic soils, limited availability of Ca hinders nutrient uptake, including nitrogen, phosphorus, potassium, and magnesium, leading to poor crop growth and reduced yields. Addressing Ca deficiencies in such soils is crucial for boosting agricultural productivity (6).

Magnesium (Mg) fertilization has been shown to significantly improved crop yields and physiological outcomes across different soil conditions and crop types.

As a key component of chlorophyll, magnesium availability directly influences photosynthetic efficiency in plants. A meta-analysis of 570 observations from 99 studies reported that magnesium application resulted in an average yield increase of 8.5% and an agronomic efficiency of 34.4 kg per kg of magnesium fertilizer applied (7).

Sulfur (S) is essential for numerous plant functions, including protein synthesis, nitrogen metabolism, enzyme activity, photosynthesis, and respiration. Studies have demonstrated that sulfur application increased crop yields in oilseed rape and wheat, with notable improvements in output, underscoring its importance in agricultural practices (8).

The traditional fertilizers have proven to be less efficient, prompting a shift towards customized fertilizers that target specific nutrient deficiencies. This shift has significantly improved overall efficiency of fertilizer use in crop production (9). Additionally, growing concerns regarding the environmental consequences of imbalanced fertilizer use have underscored the need of sustainable agricultural practice, such as balanced fertilization. It involves applying the appropriate type and quantity of nutrients at right time using the correct method. Over-application of fertilizers has led to soil degradation, pollution, and contributions to climate change, underscoring the need for a strategic approach to fertilizer management (10).

Low levels of secondary nutrients and micronutrients, compounded by soil acidity, continue to pose significant challenges to agricultural productivity. In response, site-specific nutrient management (SSNM) has emerged as an innovative approach for optimizing nutrient supply based on the specific geographical and temporal needs of crop. This strategy incorporates advanced technologies such as remote sensing, global positioning system (GPS), and geographic information system (GIS) to enhance fertilizer efficiency, improve crop yields, and minimize environmental impact, particularly in nutrient stressed or acidic soils (11). Strategic research efforts are ongoing to refine nutrient management practices further. Emphasis is currently placed on improving fertilizer utilization efficiency through the implementation of the 4R Nutrient Stewardship principle, which advocates for the use of the right source of fertilizers, in the right quantity, at the right time, and through the right application method (12). Several agronomic practices, like precise application, deeper placement, row placement, the use of coated fertilizers for controlled nutrient release, and timely application, have been evaluated to align with the 4R strategy (13).

Globally, the market for secondary nutrients was valued at approximately USD 36.06 billion in 2024, with projections to reach USD 49.28 billion by 2030, reflecting a compound annual growth rate (CAGR) of 5.34% from 2017 to 2030 (14). The Asia-Pacific region leads the market, driven by increased agricultural activity and the rising demand for nutrient-enriched fertilizers. Among secondary nutrients, sulfur holds the largest market share, reflecting its widespread usage (15).

This study focuses on identifying the factors influencing farmers' decisions to purchase SNFs. In Tamil Nadu, only a limited number of farmers utilize SNFs, often without a full understanding of their benefits for plant growth and soil health. The majority of farmers were not aware about the SNFs and their importance for improving crop productivity and soil health. Hence, the present study aims to analyse the factors driving farmers' purchasing behaviour and the challenges they face in adopting SNFs.

Materials and Methods

The study was conducted in four districts of Tamil Nadu: Madurai, Sivagangai, Virudhunagar, and Ramanathapuram. The major soil type in the southern zone of Tamil Nadu includes coastal alluvium, black soil, red sandy soil, and deep red soil (16). The pH range of soils in these districts varies as follows: Sivagangai (4.5 to 6.5), Ramanathapuram (6.0 to 8.5), Madurai (5.5 to 9.0), and Virudhunagar (6.1 to 9.0). The soil organic carbon content of Madurai, Sivagangai and Ramanathapuram ranges from 0.30 to 0.57%, 0.17 to 1.12%, and 0.06 to 0.80 %, respectively, with an average organic carbon content of 0.57 % in Virudhunagar. Soils in all four districts are reported to be deficient in micronutrients (17-20).

These districts were purposively selected for the study due to their significant role in agricultural production and the prevalent use of SNFs by local farmers. The study was carried out over a period from February 2024 to August 2024, involving a total sample size of 120 farmers. A convenience sampling technique was employed to select farmers from the southern agro-climatic zone of Tamil Nadu, ensuring the inclusion of those who actively use SNFs. This method enabled a focused analysis of the factors affecting fertilizer usage, purchasing decisions, and the challenges faced by farmers in obtaining and using SNFs in these regions.

Tools and techniques of data analysis

Factor analysis is a statistical method used to examine the relationships among a large set of variables and to classify these variables based on their shared underlying dimensions, referred to as factors. In the present study, factor analysis was utilized to effectively group the prominent factors influencing farmers' purchasing behaviour toward SNFs.

Additionally, the RII method was employed to assess the significance of specific causes and effects by evaluating

their likelihood of occurrence and impact. This approach utilizes a five-point Likert scale and was applied in this study to rank the challenges faced by farmers in the usage of SNFs.

Factor analysis

The factors influencing purchasing behaviour were determined through factor analysis, a statistical method used to analyse interrelationship among a large number of variables and explain these variables in terms of their common underlying dimension (factor) (21).

General from of a factor is,

F=x1+x2+.....xk

Factor loading = Correlation of each variable with the underlying factor

Factor score = Subject response x factor loadings

Relative important index (RII)

The RII was used to rank the challenges faced by in using SNFs.

The formula for the RII using a Likert scale is following (22):

$$RII = \Sigma W/(A*N)$$

Where,

W: The weight given to each factor by respondents, ranging from 1 to 5 on the Likert scale

A: The maximum possible weight

N: The total number of respondents

Result and Discussion

The general characteristics of the farmers, their purchasing behaviour, the factors influencing their buying behaviour, and the constraints faced by the farmers in using SNFs were analysed, and the results are presented below.

General characteristics of the respondents

The socioeconomic background of the respondent, such as age, gender, family type, education level, landholding size, farming experience, occupation, and annual income, was analysed and is presented in Table 1.

The survey results indicated that the majority of the sample respondents were male, comprising 90% of the sample. The largest age group was 46 to 55 years, making up 30% of the respondents, followed closely by those over 56 years at 28.3%. In terms of family structure, 60% of the respondents belonged to from nuclear families, while the remaining 40% were from joint families. Education levels were predominantly low, with 46.6% being illiterate, 30% having some schooling, 13.33% having attended college, and 10% holding professional degrees.

Regarding landholding sizes, the majority of respondents were medium-sized farmers (43.33%), followed by small farmers (31.66%), marginal landholders (15%), and large landholders (10%).

Farming experience varied, with 31.6% having 11–20 years of experience, 20% with less than 10 years, and another 20% with more than 20 years of experience. Most respondents were primarily engaged in agriculture (68.33%), while 23.3% combined agriculture with private sector work, and 8.33% were involved in government jobs.

In terms of annual income, 70% of respondents earned below ₹5 lakhs, 18.33% earned between ₹5–10 lakhs, 8.33% earned ₹10–15 lakhs, and only 3.33% earned above ₹15 lakhs.

The findings indicate that SNFs were predominantly used by older farmers with significant farming experience and medium-sized landholdings. This demographic profile provides valuable insights into the primary users of these fertilizers.

Buying behaviour of SNFs

The mode of purchase, duration of usage, frequency of purchases per year, sources of income, and repeated use of secondary nutrients were analysed. The results are presented in Table 2.

The survey results showed that the majority of respondents (86.66%) preferred to purchase SNFs with cash, while a smaller percentages (13.33%) relied on credit. Regarding the duration of SNF usage, the highest percentage of respondents (43.33%) reported using these fertilizers for 1-3 years, by 21.6% who had been using them for 4–6 years. A minority had less than one year of experience (16.66%) or over six years (18.33%) of usage.

The frequency of SNF purchases varied among respondents. Most farmers (45%) made purchases once a year, while 36.66% purchased twice annually. Smaller proportions reported purchasing three times (6.66%), four times (8.33%), and five or more times (3.33%) annually.

The primary sources of information about SNFs were field officers (35%) and dealers (28.33%). Other sources included fellow farmers (13.33%), farmer meetings (12.5%), and the agriculture department (8.33%), with advertisements contributing the least at 2.5%.

When analyzing the reasons for repeated purchases, product performance emerged as the most significant factor, cited by 35% of respondents. Field staff opinions also played a major role (23.33%), followed by dealers (18.33%), product quality (13.33%), and brand image (10%).

These findings underscore the predominance of cash transactions for fertilizer purchases, with field officers serving as the primary source of information. Product performance was identified as a key determinant for repeated purchases. The data also indicates a diverse range of purchasing frequencies and varying levels of familiarity with SNF usage among respondents.

Dosage of SNF fertilizer used by the sample farmers

The major crop cultivated, along with the dosage and timing of secondary nutrient fertilizer application, were analysed and are presented in Table 3. The details for each crop are as follows:

Rice: A dosage of 25 kg of SNFs was applied per acre on the 8th and 28th days after sowing.

Banana: Farmers applied 100 grams of SNFsper acre during

Table 1. General characteristic of the sample respondents

Characteristics	Category	No. of respondents	% of respondents
Gender	Male	108	90
	Female	12	10
	Total	120	100
Age(years)	18-25 years	6	5
	26-35 years	14	11.6
	36-45 years	30	25
	46-55 years	36	30
	>56 years	34	28.3
	Total	120	100
Type of family	Nuclear	72	60
	Joint	48	40
	Total	120	100
Educational status	Illiterate	56	46.6
	School	36	30
	College	16	13.33
	Professional degree	12	10
	Total	120	100
Size of land holding	Marginal (<1 ha)	18	15
	Small (>1- 4 acre)	38	31.66
	Medium (4-10 acre)	52	43.33
	Large (>10 acre)	12	10
	Total	120	100
Farming experience	Below 10 years	24	20
	11 to 20 years	38	31.6
	Above 20 years	24	20
	Total	34	28.33
Occupation of farmer	Agriculture only	82	68.33
	Agriculture and private	28	23.3
	Agriculture and government	10	8.33
	Total	120	100
Annual income	Below 5 lakhs	84	70
	5-10 lakhs	22	18.33
	10-15 lakhs	10	8.33
	Above 15 lakhs	4	3.33
	Total	100	100

the 2nd, 4th, 6th, and 8th months of cultivation.

Cotton: A dosage of 50 kg of SNFs was applied per acre on the 30th day after sowing.

Brinjal: A mixture comprising 30% SNFs, 50% NPK (nitrogen, phosphorus and potassium), and 10% micronutrients was applied during the basal stage and again at the flowering stage.

Bhendi: The same mixture 30% SNFs, 50% NPK, and 10% micronutrients was applied at both the basal and flowering stages.

Table 2. Purchasing behavior of farmers

Characteristics	Category	No. of respondents	% of respondents
Mode of purchase	Cash	104	86.66
	Credit	16	13.33
	Total	120	100
Duration of using SNFs	Less than 1 year	20	16.66
	1- 3 years	52	43.33
	4-6 years	26	21.6
	Above 6 years	22	18.33
	Total	120	100
Frequency of SNFs purchases per year	Once	54	45
	Twice	44	36.66
	Three times	8	6.66
	Four times	10	8.33
	Five or more times	4	3.33
	Total	120	100
Source of information	Field officer	42	13.33
	Dealers	34	28.33
	Fellow farmer	16	8.33
	Farmers meeting	15	12.5
	Agriculture department	10	2.5
	Advertisement	3	35
	Total	120	100
Reason for repeatedly purchasing SNFs	Product performance	42	35
	Field staff opinion	28	13.33
	Dealer opinion	22	10
	Product quality	16	23.33
	Brand image	12	18.33
	Total	120	100

Factors influencing buying behaviour

The adoption of SNFs is influenced by multiple factors. This study examines the factors influencing decision of farmers to incorporate these secondary nutrients into their farming practices are examined using factor analysis. Table 4 and Fig. 1 represents the detailed information on these influencing factors.

The factor analysis identified four key constructs influencing farmers' decisions to purchase SNFs.

Interpersonal influence

It is the most significant factor influencing the decision of farmers to purchase SNFs. The following elements were highly influential: field staff advice (0.957), dealer advice (0.956), and reference from fellow farmers (0.904), indicating

Table 3. Dosage of secondary nutrient fertilizer

Major crop	Dosage	Time of using
Rice	25 kg per acre	8th and 28th Days
Banana	100 gram per acre	2nd ,4th, 6th and 8th month
Cotton	50 kg per acre	At time of 30th day
Brinjal	30 % + NPK 50 % + 10 % micronutrient	Basal application + Flowering stage
Bhendi	30 % + NPK 50 % + 10 % micronutrient	Basal application + Flowering stage

Table 4. Factor analysis

1. KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of sampling adequacy		0.721
Bartlett's test of sphericity	Approximate chi-square	292.71
	Degrees of freedom	99
	Significance	<0.001

2. Rotated component matrix

Factors	Variables	Factor loading
Interpersonal influence	Field staff advice	0.957
	Dealer advice	0.956
	Reference from fellow farmers	0.904
Product satisfaction and experience	Product performance	0.808
	Product quality	0.783
	Past experience	0.701
Brand and marketing	Brand image	0.709
	Product nutrient proposition	0.672
	Advertisement	0.594
Financial and availability	Price	0.639
	Credit	0.610
	Availability of product	0.574

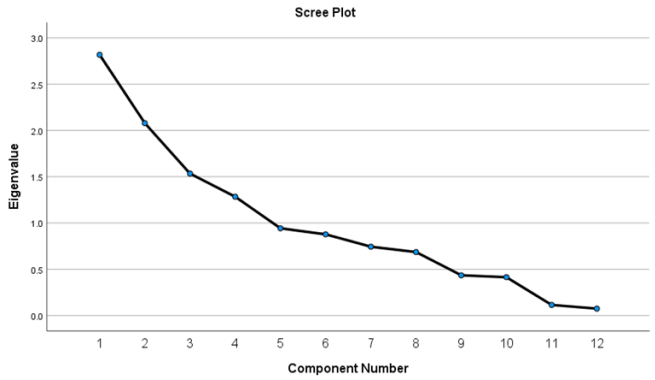

Fig. 1. Scree plot diagram.

that farmers heavily rely on trusted recommendations.

Product satisfaction and experience

Farmers' decisions were also significantly influenced by their satisfaction with and prior experience of products. Key factors included: product performance (0.808), product quality (0.783), and past experience (0.701), highlights the importance of product efficiency and prior usage.

Brand and marketing

The influence of branding and marketing was another important construct, driven by brand image (0.709), product nutrient proposition (0.672), and advertisement (0.594), indicate that the impact of brand reputation and effective communication.

Financial and availability factors

Affordability and accessibility of products also played a critical role, with the following factors being prominent: price (0.639), availability of product (0.610), and credit (0.574), underline the significance of affordability and product accessibility.

A previous study found that word of mouth, perceived product availability, attitude towards agrochemicals, price, and product knowledge were significantly factors influencing farmers' buying behavior towards agrochemicals in the Ampara district. Among these, word of mouth had the strongest impact, followed by product availability (12, 23).

Constraints faced by farmers in the usage of secondary nutrients

Farmers faced several challenges when adopting SNFs. The primary constrains identified include high costs, limited access to credit, poor solubility in soil, inferior product quality, and the lack of observable effects on crop yields. Detailed information on these challenges is provided in Table 5.

The most significant challenge identified by farmers is the high price of SNFs (0.536), making affordability a major barrier for many farmers in adopting these products. This is closely followed by the non-availability of credit (0.453), highlighting the financial challenges and the limited access to credit facilities, which hinders their ability to purchase fertilizers.

The third major constraint is poor solubility in soil (0.386), suggesting that many farmers are concerned about the compatibility of these fertilizers, with the soil conditions prevalent in their regions. The fourth issue is poor quality (0.33), reflecting apprehensions about the reliability and efficacy of the fertilizers available in the market. Finally, the lack of observable effects on yield (0.306) emerged as another key concern, indicating that some farmers doubt about the visible benefits. Overall, the findings reveal that the high price and non-availability of credit are the most critical issues, and addressing these constraints could significantly improve the adoption of SNFs.

Table 5. Constraints faced by farmers

Particulars	RII	Ranking
High price	0.536	I
Non availability of credit	0.453	II
Poor solubility in soil	0.386	III
Poor quality	0.33	IV
Lack of observable effects on yield and soil	0.306	V

Conclusion

The study examines the factors influencing farmers' decisions to purchase SNFs in Southern Tamil Nadu. While these fertilizers play a vital role in enhancing soil health and crop productivity, their adoption is hindered by several challenges.

Farmers' purchasing decisions are shaped by four main categories of factors: interpersonal influence, product satisfaction and experience, brand and marketing, financial and availability.

In which, interpersonal influence includes guidance from field staff, dealer advice, and reference from fellow farmers. Product satisfaction and experience encompasses factors such as product performance, quality, and prior usage experience. Brand and marketing considerations include brand image, nutrient proposition, and the influence of

advertisement. Financial and availability factors are dominated by concerns regarding price, access to credit, and product availability.

Despite their awareness of SNFs, farmers often lack a comprehensive understanding of their distinct benefits, particularly as these are frequently used in conjunction with primary fertilizers like NPK. The key barriers identified are high costs and limited access to credit, which significantly restricts broader adoption. Addressing these issues through enhanced farmer education, affordable pricing mechanisms, and streamlined credit access is crucial. Targeted strategies, such as improving awareness of the specific benefits of SNFs, reducing financial barriers, and ensuring consistent product availability, are essential to promoting their effective use. These measures will farmers adopt these fertilizers more effectively, boosting crop yields and supporting sustainable agriculture in the region.

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Authors' contributions

GP participated in research, survey and data analysis. MD contributed by invaluable guidance in formulating the research concept, securing financial support for the research and publication, and approving the final manuscript. PDR contributed critical contributions in developing the research ideas, reviewing the manuscript, and providing financial support for the research and publication process. GSR contributed by imposing the experiment, editing, summarizing, and revising the manuscript, as well as financial support in facilitating the writing and publication of this article. CM helped in summarizing and revising the manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

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