



Local Awareness and Perception of Fertilizers: A Case Study in Anuradhapura District, Sri Lanka

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Abstract For many decades, the agriculture sector in Sri Lanka has been dependent on chemical fertilizers, providing near-term benefits but posing substantial long-term environmental impacts. This practice underscores the challenge of transitioning to more sustainable farming strategies. Through structured questionnaires and in-depth discussions, we explored the awareness and perception of fertilizer application practices among paddy farmers in the Tisa Wewa irrigation scheme in the dry zone of Sri Lanka. Most farmers (78%) relied solely on inorganic fertilizers, while an approach of mixed inorganic and organic fertilizers was adopted by 19%. Only 3% of farmers used solely organic fertilizer. Of the respondents utilizing inorganic fertilizer, 44.1% applied the recommended amount set by the Department of Agriculture, Sri Lanka, while 42.6% applied greater than the recommended amount, and 13.2% applied less than the recommended amount. The survey and interview data indicated that the current practice and high reliance on inorganic fertilizer is due to the limitations of organic fertilizers governed by the large amount needed, the longer necessary to release nutrients, and the limited manure availability. Most farmers (87.1%) expressed a strong preference for adopting mixed organic and inorganic fertilizer applications in the future, emphasizing the use of high-quality input products, reflecting a forward-looking approach to sustainable agriculture, combining the benefits of both organic and inorganic fertilizers. The statistical results strongly indicate that education and awareness reduce the over-dependency on inorganic fertilizers and significantly influence the adoption of sustainable fertilizer practices.

Keywords fertilizer application, paddy farmers, awareness, perception, Sri Lanka

INTRODUCTION

Sri Lanka's monsoon climate supports two annual paddy seasons (Yala and Maha), with rice farming occupying about 29% of the country's total cultivated land (Department of Census and Statistics, Sri Lanka, 2023). The government's fertilizer subsidy program established in 1962 encourages farmers to adopt high-yielding rice varieties responsive to inorganic fertilizers. This program has made inorganic fertilizers affordable, with the unintended consequence of farmers' overuse (De Silva et al., 2020). As such and for several decades, the agriculture sector in Sri Lanka has been dependent on inorganic fertilizers. Studies indicate significant inefficiency in inorganic fertilizer application for paddy cultivation, with 50-70% of fertilizer inputs being lost through volatilization, leaching, or other pathways (Sirisena et al., 2016). Hence, excessive use of inorganic agricultural inputs results in serious environmental and health effects (Siriwattananon et al., 2014). Fertilizer runoff causes water pollution, especially eutrophication since the excess nitrogen and phosphorus from fertilizers increase algae growth and deteriorate water quality. Furthermore, repeated inorganic fertilizer degrades soil quality by altering pH and depleting essential micronutrients and organic matter contents, leading to a vicious circle of dependence on synthetic inputs. Moreover, water bodies and soil become contaminated with nitrates, cadmium, and fluoride, which are harmful to human health.

Hence, sustainable agricultural practices become necessary for environmental integrity and human health (Siriwattananon et al., 2014).

The abrupt shift to an exclusive organic agriculture policy in Sri Lanka in April 2021, which banned synthetic fertilizers and pesticides, was implemented by the Sri Lankan government. Though The policy aimed to reduce chemical dependency and promote environmental sustainability, it was reversed within months due to severe crop yield declines (Wijerathna et al., 2024). The crisis underscored the need for phased transitions, thus in October 2022, a new approach was introduced recommending a balanced use of 30% organic and 70% inorganic fertilizers for paddy cultivation. (MALLI, 2022). Farmers were encouraged to obtain an organic certificate or Good Agricultural Practices certification. However, still, it remains unclear whether Sri Lankan paddy farmers apply sufficient amounts of organic matter or effectively utilize specific sources. Therefore, this study aimed to assess farmers' awareness and perceptions of fertilizer application to identify issues and/or gaps in current practices, explore the barriers to adopting more balanced fertilizer application strategies, and generate and propose practical recommendations facilitating the transition towards sustainable fertilizer practices.

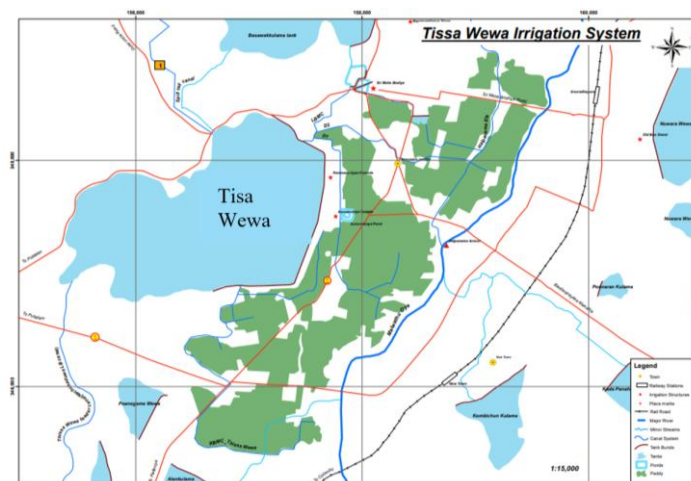
OBJECTIVE

This research aimed to measure and analyze local awareness and perceptions regarding fertilizer application among paddy farmers in Sri Lanka's dry zone.

METHODOLOGY

Study Area

Anuradhapura District in the north, central plain of Sri Lanka, is identified as one of the major paddy farming districts, with high productivity and production accounted for 12% of Sri Lanka's paddy production during the 2023 Yala season (Department of Census and Statistics, Sri Lanka, 2023). The study was conducted in the Tisa Wewa irrigation scheme in Anuradhapura District (Fig. 1), using a local paddy farming community. This area was selected as a representative site due to its significant role in supporting paddy cultivation in the region and its practical feasibility. The long-standing agricultural history of Tisa Wewa and a wide range of farming practices allowed for a comprehensive understanding of local awareness and perception of fertilizer application. By selecting this area, the study could capture diverse perspectives on fertilizer application, providing a representative context for examining fertilizer application behavior within Sri Lanka's paddy farming sector and facilitating the development of recommendations applicable to similar regions.



Source: Irrigation Department, Sri Lanka, 2023

Fig. 1 Scheme map of Tisa Wewa irrigation scheme

Data Collection

The primary data were collected from August to September 2023, through a structured questionnaire survey with close-ended questions supplemented by informant discussions. The study was focused on the farmers involved in paddy cultivation under the Tisa Wewa irrigation scheme, which was organized into five major farm organizations. Stratified random sampling was employed to ensure reliable representativeness by dividing the population into five strata, corresponding to the five farm organizations, and proportionally randomly selecting farmers from each stratum. The minimum sample size was determined as in Eq. (1), assuming a success or failure proportion of 0.5, with a 95% confidence level and a 10% margin of error. Seventy farmers were selected from a total of 220, for the study based on the calculated minimum required sample size (67). The list of registered farmers in the study area was provided by the Department of Agrarian Development in Sri Lanka.

$$n = \frac{96 N}{N + 96} \quad (1)$$

Where N = population size and n = sample size.

Data Analysis

The survey questionnaire was developed based on a review of existing literature on agricultural practices and fertilizer use. Before finalizing the questionnaire, a preliminary survey was conducted with 10 farmers to ensure clarity and relevance. It provided valuable feedback that helped refine the final questions used in the study. The main areas covered in this survey include demographic and farming characteristics, awareness and perception of fertilizer application, and future preferences. Purpose and survey questions related to each category are shown in Table 1. Data collection was conducted using pencil-and-paper surveys administered through face-to-face interviews to accommodate rural farming communities. The data were descriptively analyzed using Microsoft Excel and SPSS, employing frequency distributions, percentages, and correlation analysis to interpret and present the findings. In addition, relevant secondary data regarding the fertilizer application were also reviewed.

Table 1 Survey questions associated with categories

Category	Purpose	Survey question
Demographic and farming characteristics	Define Age	What is your age?
	Define the highest educational level	What is your highest level of education?
	Define farming experience	How long have you been paddy farming? (Years)
	Define farm area	What is the current paddy cultivated area (in ha)?
Awareness and perception of fertilizer application	To define the current fertilizer type	What kind of fertilizer do you add to the field? (Inorganic/Organic/Both)
	To define the current inorganic fertilizer amount	How do you add inorganic fertilizer to the field? (Recommended amount/higher or less)
	To evaluate the awareness of the environmental impact of inorganic fertilizer	Do you think the usage of inorganic fertilizers results in adverse effects on the environment and health? (Yes/No)
	To define organic fertilizer type usage	What kind of organic fertilizer do you add to the field? (open-ended or pre-configured list.?)
	To measure farmer knowledge of organic fertilizer benefits	Advantages of organic fertilizers (open-ended or pre-configured list.?)
	To rank order practical issues when using organic fertilizer	Rank the given constraints (need large quantities, more time taken to release nutrients, high cost of manure, limited supply of manure, unable to self-produce)
Future preference of fertilizer application	To identify the farmer's preference for future fertilizer practices	What is your preferred method for future fertilizer applications? (Inorganic/Organic/Mixed application)

Source: Questionnaire survey in August to September 2023

RESULTS AND DISCUSSION

Demographic and Farming Characteristics of Farmers

Table 2 shows the demographic and farming characteristics of the respondents (N=70). Most respondents (85.7%) were male, with a mean age of 54.2 years (SD=12.56). Notably, only 2.9% of respondents were less than 30 years of age reflecting the younger generation's minimal involvement in paddy cultivation.

Most farmers (44.3%) completed secondary education and sat for the General Certificate of Examination (GCE) Ordinary Level, which most respondents (74%) passed. The second largest proportion (32.9%) completed their GCE Advanced Level. A small proportion (8.6%) obtained a bachelor's degree in any field. According to the findings, there is potential for agricultural development and knowledge-based improvements in rural farming communities due to many farmers having reached at least a foundational level of secondary education.

Most farmers (47.1%) had over 15 years of experience. Most farmers (60%) were small-scale farmers cultivating less than 1.2 hectares (ha) of paddy land, 22.9% cultivated medium-scale farmlands (1.21-2 ha), and the remainder cultivated larger-scale farms.

Table 2 Demographic and farming characteristics of respondents

Factor	Category	Frequency	Percentage (%)
Gender	Male	60	85.7
	Female	10	14.3
Age (years)	Less than 30	2	2.9
	31 - 44	17	24.3
	45 - 60	29	41.4
	More than 60	22	31.4
Highest educational level	Primary	2	2.8
	Grade 6 - 8 (Middle Level)	8	11.4
	Grade 9 - 11 (up to GCE Ordinary Level)	31	44.3
	GCE Advanced Level	23	32.9
	Degree	6	8.6
Farming experience under Tisa Wewa irrigation scheme (years)	Less than 5	7	10.0
	5-10	11	15.7
	11-15	19	27.1
	More than 15	33	47.1
Cultivating paddy area under Tisa Wewa irrigation scheme (ha)	<1.2	42	60.0
	1.21-2	16	22.9
	2.01-4	5	7.1
	> 4	7	10.0

Source: Results from the questionnaire survey in August to September 2023

Current Fertilizer Application Behavior

The primary inorganic fertilizers used for paddy cultivation included Urea, Triple Super Phosphate (TSP), and Muriate of Potash (MOP). Organic materials such as rice straw, green leaves, compost, and biofertilizers were also utilized by respondents in the region. Manuring applications in the paddy fields were notably limited to only cow manure.

As shown in Figure 2(a), most farmers (78%) relied solely on inorganic fertilizers, while a mixed approach of inorganic and organic fertilizers was adopted by 19%. Only 3% of farmers used solely organic materials. This outcome aligns with previous findings, such as by Senanayaka (2022), that only organic fertilizer usage in the country was limited to 1% of the rice farmers. 44.1% of respondents applied the recommended amounts for inorganic fertilizer applications defined by the Department of Agriculture, Sri Lanka (2013), while 42.6% used a greater than the recommended amount. Fig. 2(b). 13.2% of farmers used less than the recommended amounts and the same category also included the farmers who incorporated organic matter into their practices. Over-application still

practiced by farmers, indicates potential misuse of inorganic fertilizer, influenced by the belief that more fertilizer equates to higher yields. Some respondents mentioned that they had to apply higher quantities of inorganic fertilizers due to the poor quality of inorganic fertilizers, to achieve the desired crop yield.

These behaviors govern a vicious cycle of soil quality degradation, reduced crop yield, and the need for more fertilizer. Therefore, targeted strategies are required to promote greater adoption of sustainable agricultural practices.

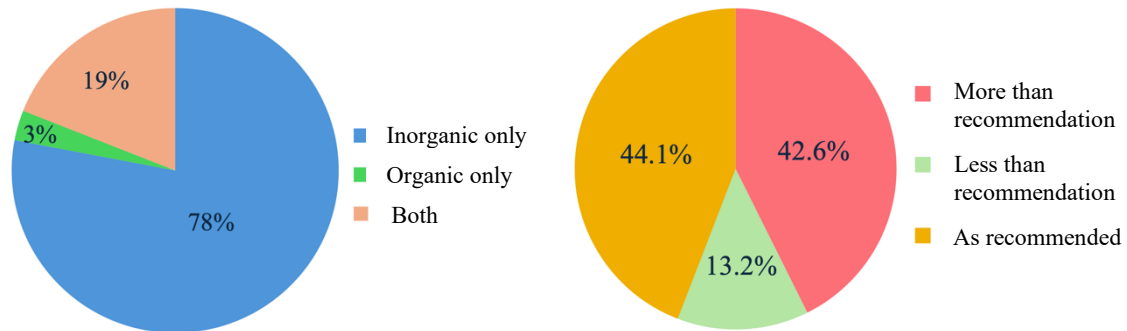


Fig. 2 Fertilizer application practices (a) and application rate of inorganic fertilizer (b)

Perceived Environmental and Health Risks Associated with Inorganic Fertilizers

Respondents (68.6%) revealed a general awareness of the potential negative environmental and human health impacts of inorganic fertilizers. The main perceived risks entail soil degradation, water pollution, loss of biodiversity, and chronic diseases such as cancers. Perceptions are formed based on self-observation, local knowledge, and information shared within the farming community. Despite this awareness, respondents hesitate to avoid or reduce inorganic fertilizer usage due to a perceived lack of other efficient and effective alternatives. Consequently, a recommendation is made to related organizations to act on enhancing the use of organic or integrated nutrient management practices, bringing knowledge to farmers on how to effectively and safely use fertilizers which could help mitigate some of the perceived risks while maintaining agricultural productivity.

Current Usage and Knowledge of Organic Fertilizers

Results revealed that among farmers applying organic materials to their fields, 60% used rice straw with green leaves. *Gliricidia* (*Gliricidia sepium*) leaves were used most often due to their high availability. Additionally, 40% of farmers utilized self-prepared compost, 20% relied on commercial compost, 6.7% used cow manure, and 6.7% used bio-fertilizers. However, some farmers expressed concerns about the perceived lower quality of commercial compost products. Cow manure was the sole animal waste used by respondents since the shortage of animal manure has resulted in significantly higher costs.

Key advantages of organic fertilizers mentioned by the respondents were improved plant growth (75.7%), improved soil fertility (52.9%), enhanced soil water holding (27.1%), and reduced soil erosion (12.9%). Such a consensus reflects the belief in organic matter's positive impact on crop development. However, a notable percentage (22.9%) expresses uncertainty, which might indicate an awareness gap. Targeted educational initiatives are essential to bridge this gap, improving farmers' understanding of the significance of organic matter in agriculture.

Constraints Associated with Organic Fertilizers

The average ranking method (Eq. 2) according to Yusufi and Yamada (2019), was used to determine influential constraints to organic matter application. Which have the lowest average ranks, indicating

they are critical issues to address. Table 3 revealed that the most significant constraint was the need for large quantities of organic materials compared to inorganic fertilizers.

$$\text{Average rank} = \frac{X_1P_1 + X_2P_2 + \dots + X_nP_n}{\text{Total response count}} \quad (2)$$

Where X_n = response count for each choice, P_n = ranked position.

Table 3 Average ranking for constraints of organic fertilizer application

Constraints	1 st	2 nd	3 rd	4 th	Average rank
Need large quantities	41	21	8	0	1.5
More time is taken to release nutrients	27	41	1	0	1.6
High cost of manure	2	2	24	14	1.9
Limited supply of manure	0	5	29	33	3.3
Unable to self-produce	0	1	8	23	4.5

Source: Results from the questionnaire survey in August to September 2023

Farmers face challenges in obtaining adequate quantities of necessary materials, either because they are not available at reasonable prices or because they lack the means to prepare by themselves. The second important constraint was more time to release nutrients primarily due to challenges in obtaining standard or quality materials. Additionally, the high cost and limited availability of manure further compounded the issue. The inability to produce self-produce due to time and space was identified as a lesser constraint. Previous studies also revealed that limited availability and poor quality of organic materials were the most severe barriers to organic farming (Wijerathna et al., 2024). Therefore, to make it viable there is an urgent need to address the availability of quality organic products.

Future Preference of Fertilizer Application

The majority (87.1%) preferred a mixture of inorganic and organic fertilizers in the field, while 10%, favored only organic application, and 2.9% preferred solely inorganic fertilizers. This is an increase from previous reports, in which only 58% preferred mixed systems, while 31% and 11% preferred fully inorganic and fully organic applications six months after the 2021 policy shift to exclusive organic fertilizers (Wijerathna et al., 2024). The increased uptake of mixed systems (87.1%) reflects a pragmatic response to the shortcomings of the organic-only policy, which had led to severe yield losses and economic hardship. This change reflects a positive evolution towards more sustainable forms of agriculture. Farmers expressed a high preference for this mixed approach with high-quality organic and inorganic materials under proper guidance. Additionally, this finding aligns with the previous research of Silva et al. (2020). Therefore, integrating organic fertilizers and reducing the overuse of chemical fertilizers would be more widely accepted by farmers, and offering significant support through the government and private sector involvement is highly recommended.

Pearson Correlation Analysis

Pearson correlation and Sig. (2-tailed) p-values help determine the strength and significance of relationships between variables, with significant relationships indicating that the variables are meaningfully related. The correlation analysis revealed several significant relationships between the variables in the study, providing valuable insights into farming practices and the factors influencing them. A low negative correlation between the age group and cultivated area was observed where older farmers tend to cultivate smaller paddy areas ($r = -0.332$, $p = 0.005$). This trend suggests that older farmers may reduce the size of their paddy fields, possibly due to several factors such as retirement, health issues, or the transfer of land to younger generations. Interestingly, age alone did not have a strong influence on fertilizer preference.

Educational qualifications showed significant moderate positive correlations with several farming variables such as fertilizer type used ($r = 0.448$, $p < 0.001$), awareness of impacts of inorganic

fertilizers ($r = 0.662$, $p < 0.001$), and preferred fertilizer method ($r = 0.478$, $p < 0.001$). Specifically, it had a significantly strong negative correlation ($r = -0.707$, $p < 0.001$) with the application rate of inorganic fertilizer, which is preferred for the recommended amount or less. These findings highlighted that farmers with higher educational qualifications are more likely to choose organic fertilizers and adopt more sustainable farming practices, suggesting that education influences the choice of fertilizers and farming practices.

Awareness of the impacts of inorganic fertilizers demonstrated a significant moderate negative correlation with inorganic fertilizer application rate (IFR) ($r = -0.609$, $p < 0.001$), suggesting that those more aware of the environmental impact of fertilizers are less likely to use inorganic methods or preferred for recommended rates or less. There was a significant positive relationship with the preferred fertilizer method ($r = 0.468$, $p < 0.001$), suggesting that awareness of fertilizers is associated with preferences for organic fertilizers. These results strongly indicate that both education and awareness significantly influenced the adoption of more informed and sustainable fertilizer practices.

Table 4 Results of Pearson correlation analysis

		AG	EQ	FD	CA	FT	IFR	IFI	PFM
AG	Pearson Correlation	1	-0.006	0.223	-0.332**	0.169	-0.117	0.088	0.006
	Sig. (2-tailed)		0.958	0.064	0.005	0.161	0.334	0.471	0.957
EQ	Pearson Correlation		1	-0.313**	0.124	0.448**	-0.707**	0.662**	0.478**
	Sig. (2-tailed)			0.008	0.308	0.000	0.000	0.000	0.000
FD	Pearson Correlation		**	1	-0.193	0.268*	-0.216	0.105	-0.143
	Sig. (2-tailed)				0.109	0.025	0.073	0.386	0.239
CA	Pearson Correlation	**			1	-0.220	0.098	0.035	0.136
	Sig. (2-tailed)					0.068	0.418	0.774	0.261
FT	Pearson Correlation		**	*		1	-0.620**	0.335**	0.131
	Sig. (2-tailed)						0.000	0.005	0.280
IFR	Pearson Correlation		**			**	1	-0.609**	-0.190
	Sig. (2-tailed)							0.000	0.115
IFI	Pearson Correlation		**			**	**	1	0.468**
	Sig. (2-tailed)								0.000
PFM	Pearson Correlation		**					**	1
	Sig. (2-tailed)								

Note: AG= Age group, EQ= Educational qualifications, FD= Farming duration, CA=Cultivated area, FT=Fertilizer type (inorganic, organic, both), IFR=Inorganic fertilizer rate (recommended, less or more), IFI=Inorganic fertilizer impact, PFM=Preferred fertilizer method (** $p < 0.01$, * $p < 0.05$)

Recommendations

Government and private sector efforts should focus on promoting organic fertilizer use, ensuring the availability of compost and manure at subsidized rates, improving supply chains, and supporting local production. Training and education in effective utilization and home composting should be provided to address farmer constraints while exploring more efficient application methods. Policymakers should encourage organic and inorganic fertilizers mixed approach, ensuring sustainable soil fertility and crop productivity. Given the strong link between education, awareness, and fertilizer practices, agricultural extension programs should focus on improving farmers' knowledge of efficient fertilizer use and integrated nutrient management. Practical workshops, field demonstrations, and research-based information dissemination will support sustainable paddy farming practices in Sri Lanka.

CONCLUSION

The study found that education and awareness of the effects of inorganic fertilizer greatly influence farmers' intentions to adopt organic-based practices. Farmers with at least secondary levels of

education were more likely to apply integrated nutrient management and showed greater environmental awareness. However, insufficient availability and low quality of organic materials, coupled with inadequate animal manure, were the key factors limiting farmers from adopting organic farming. Although 87.1% of the farmers preferred a mix of organic and inorganic fertilizers, this would show a gradual change toward sustainable practices. It also points to the opportunity to promote environmentally friendly, balanced fertilizers to improve productivity without harming the environment.

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