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Influence of Socio-economic and Communication Factors on Bio-fertilizers Knowledge and Adoption among Paddy Farmers in Vellore District of Tamil Nadu, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

This study examines the relationship between selected socioeconomic and communication characteristics of paddy farmers in Gudiyattam Taluk, Vellore District, Tamil Nadu, with their awareness and adoption of recommended bio-fertilizers practices. Using an ex-post facto research design, proportionate random sampling was employed to select 120 farmers from six villages. Data were collected through a pre-tested structured interview schedule and analysed using correlation and multiple regression techniques. Variables considered include annual income, farm size, social participation, extension agency contact, and media exposure.

The findings revealed that most respondents were small farmers with medium levels of income, social participation, media exposure, and extension contact. Among all the variables studied, only extension agency contact showed a significant positive relationship with both awareness and adoption levels at a 5% level of significance, while other variables were found to be non-significant. The results highlight the critical role of frequent and meaningful interaction with extension personnel in enhancing farmers' understanding and sustained use of bio-fertilizer technologies. The study emphasizes the need to strengthen decentralized distribution systems and provide incentives for eco-friendly inputs to improve accessibility and long-term adoption. These insights are valuable for researchers, policymakers, and extension functionaries in formulating targeted strategies to promote sustainable rice cultivation.

Keywords: Paddy cultivation; bio-fertilizers; communication variables; socio-economic variables; adoption behaviour.

1. Introduction

Paddy is a significant cereal crop worldwide, accounting for more than half of total food production. It has a long history of cultivation, notably in Asia, and is still vital to national economies and rural livelihoods. Known as the "home of paddy," India is huge producer as well as consumer, trailing only China. In addition to reaching self-sufficiency, the country has become one of the top rice exporters during the previous four decades, thanks to scientific developments and development plans. It grows in a number of environments around the world, including rain-fed uplands and irrigated lowlands, and on soil types ranging from clay and loam to red and black soils, with clay loam being the most beneficial. Wetland paddy produces larger yields when planted in well-watered areas than upland paddy does in mountainous and rain-fed places. (FAO, 2023 and Khush 2022, Food and Agriculture Organization of the United Nations, 2023, Arunkumar, 2002, Sarveshkumar et al., 2014)

Despite its diversity, Asia continues to dominate world rice production, accounting for about 90.00 per cent of total output, although Sub-Saharan Africa and Latin America are also experiencing steady growth (IRRI, 2021, Balu, 2018, International Rice Research Institute, 2021, Ramsundar, 2016, Vijayakumar, 2017). When applied to soil, microorganism-containing biofertilizers have the ability to boost soil fertility and promote plant development (Thirumal et al., 2025, Singh et al., 2024). They are critical for the development of sustainable agriculture and increasing plants' ability to absorb nutrients via nitrogen fixation, crop development stimulation, and the production of growth-enhancing compounds. *Azolla, Azospirillum, Phosphobacteria, Cyanobacteria*, and *Pseudomonas fluorescents* are some of the beneficial bacterial taxa discovered and widely employed as bio-fertilisers in paddy production. *Vesicular-arbuscular mycorrhiza*, a phosphate-solubilising fungus, also utilized as a bio-fertilizer. As a result, these five bio fertilizers were chosen to be the focus of this study. India is a prominent global producer and consumer of bio-fertilisers.

There are already more than 60 bio-fertiliser production facilities in India. Tamil Nadu is the state with the most manufacturing capacity, followed by Gujarat, Maharashtra, Madhya Pradesh, and Uttar Pradesh. The State Government of Tamil Nadu now operates six production facilities located in the districts of Cuddalore, Salem, Trichy, Tanjore, Pudukkottai, and Ramanathapuram, with a combined yearly production capacity of 200 tons.

In August 2017, a single Liquid Bio-Fertiliser Production Unit was established under the NADP

program in the Natham hamlet of Gudiyattam Block in the Vellore district.

The facility produces and disperses phosphobacteria, azospirillum, and rhizobium liquid bio-fertilizers for pulses, paddy, and other crops. The facility creates and supplies Vellore and Thiruvannamalai Districts with liquid bio-fertilizerss of phosphobacteria, azospirillum for paddy and other crops, and rhizobium for pulses. There is also a private liquid bio-fertiliser company called OK Biosystems in Kochalur at Gudiyattam in Vellore district.

2. Materials and Methods

A sample of 120 respondents was drawn from six villages in the Gudiyattam taluk of Vellore District, Tamil Nadu, using proportional random selection. Data for the ex post facto study design were acquired using a structured interview schedule that included five bio-fertilizers and eleven related activities. The interview schedule was written in English and tested in a non-sample context to discover and correct any errors before being finalized. Since local farmers find Tamil to be quite comfortable, the interviewer adopted it. Data was collected in February and March of 2021 to be processed, coded, and statistically analysed. In the Indian state of Tamil Nadu, the city of Vellore serves as the administrative centre of the Vellore district. It was divided into four zones and is situated in the north-eastern region of Tamil Nadu on the banks of the Paalar River. In order to determine their levels and relationships with their understanding and adoption of recommended bio-fertilizers techniques, five variables were selected for this study, which fall into two broad categories: socioeconomic variables and communication variables.

2.1 Annual Income

The person who responded and his family's annual net income, including income from primary and secondary jobs, can be operationalized as annual income Ram Sundar (2016).

2.2 Farm Size

It refers to how many units of land the respondents were cultivating at the time of the inquiry. This study employed the grading methodology developed by Sakthi Ganeshan (2017).

2.3 Social Participation

This was a reference to involvement of a person in official organizational settings, either as a member or as a bearer in it. Meena (2018).

2.4 Extension Agency Contact

It is considered as how often a person contacted different extension organizations. Vijaykumar (2017).

2.5 Mass Media Exposure

The notion of media engagement referred to the frequency with which an individual farmer uses multiple media sources, such as newspapers, magazines, pamphlets, listen to radio, different publications to receive agricultural information, and so on. Aitochopi (2016).

List 1. Scoring System based on farm size and farmer categories

Sl. No.	Category	Area (acres)	Scores
1.	Marginal farmers	< 2.5	1
2.	Small farmers	2.5 – 5.0	2
3.	Big farmers	> 5.0	3

List 2. Scoring System based on Nature of participation

Sl. No.	Nature of participation	Score
1.	Member in the past	1
2.	Office bearer in the past	3
3.	Member in the present	2
4.	Office bearer in the present	4

List 3. Scoring System based on Extension agency contacts

Sl. No.	Category	Score
A	**Frequency of Contact**	
1.	Regular	3
2.	Sometimes	2
3.	Never	1
B	**Purpose of contact**	
1.	Agriculture	2
2.	Non- agriculture	1

List 4. Scoring System based on Mass media exposure

A.	Frequency of contact	Score
(i)	Daily	6
(ii)	Few days in a week	5
(iii)	Once in week	4
(iv)	Once in a month	3
(v)	Rarely	2
(vi)	Never	1
B.	**Purpose of contact**	**Score**
(i)	Agriculture	2
(ii)	Non agriculture	1

2.6 Knowledge

Knowledge generally refers to a person's familiarity with facts. Knowledge, according to Bloom *et al.* (1956), is characterized as actions and assessment scenarios that prioritize recalling facts, ideas, and phenomena through recognition or recall. Since knowledge is a fundamental component of behaviour, it is essential in influencing the adoption of better behaviours. Syed Irfan (2019) defined knowledge as farmers' understanding of the suggested bio-fertilizers procedures in paddy agriculture. The researcher used this definition to create and deliver a teacher-made knowledge test for this study. The thirty items in the test methodically covered the five main suggested bio-fertilizers practices was selected based on the judge's opinion process.

2.7 Extent of Adoption

The degree to which a person adopts a particular technology without changing its intended meaning is referred to as the "extent of adoption." Adoption, according to Rogers (1983), is the choice to use an innovation as the best available tactic. The researcher looked at the respondents' degree of acceptability of the suggested activities and identified five significant bio-fertilizers as part of the analysis. There were twenty-eight sub-items in all, and respondents were asked if they had adopted each one.

$$\text{Adoption index} = \frac{Respondent's\ total\ score}{Total\ possible\ score} \times 100$$

The score for adoption was two, whereas the score for non-adoption was one. The adoption score was calculated by aggregating each respondent's ratings for each item. This study used the adoption index formula developed by Syed Irfan (2019). Based on their results, the respondents were categorized into low, middle, and high groups by the researcher using the cumulative frequency approach.

2.8 Correlation Co-efficient

Person's product correlation co-efficient was calculated to find out the degree of association between two variables using the following formula.

$$rXY = \frac{\sum xy \frac{(\sum x) \times \sum y}{n}}{\sqrt{\left[\sum x^2 \frac{(\sum x)^2}{n}\right]\left[\sum y^2 \frac{(\sum y)^2}{n}\right]}}$$

2.9 Multiple Regression Analysis

When a factor depends on more than one factor, the sample correlation analysis will not reveal the combined relationship. For this purpose, the multiple regression technique was used to reveal the existence of linear relationship between the dependent and independent variables. Hence,

the linear multiple regression was applied as one statistical tool for the analysis. It takes the general form of

$$Y = a+b_1X_1+b_2X_2+b_nX_n$$

3. Results and Discussion

It is inferred from Table 1, that half of the respondents had a medium level of annual income (50.00%), followed by those with low levels of income (21.16%) and those with high levels of income (20.84%). The majority of respondents were solely involved in farming, which was the cause of their low and medium levels of yearly income. This result is consistent with the findings of Kathiresan (2013) and Rajeswari (2011).

From Table 2, The greatest percentage of respondents (60.00%) were small farmers, followed by big farmers (25.00%), whereas only 15% of respondents were marginal farmers, according to Table 2. Therefore, the discovery may be explained by the partition of land according to social custom from one generation to the next. This result is consistent with Sathishkumar's (2016) findings.

Table 1. Distribution of respondents according to their Annual income

Sl. No.	Category	No. of respondents	Per cent
1.	Low	35	29.16
2.	Medium	60	50.00
3.	High	25	20.84
Total		**120**	**100.00**

Table 2. Distribution of respondents according to their Farm size

Sl. No.	Category	No. of respondents	Per cent
1.	Marginal farmers	18	15.00
2.	Small farmers	72	60.00
3.	Big farmers	30	25.00
Total		**120**	**100.00**

Table 3. Distribution of respondents according to their Social participation

Sl. No.	Category	No. of respondents	Per cent
1.	Low	40	33.34
2.	Medium	54	45.00
3.	High	26	21.66
Total		**120**	**100.00**

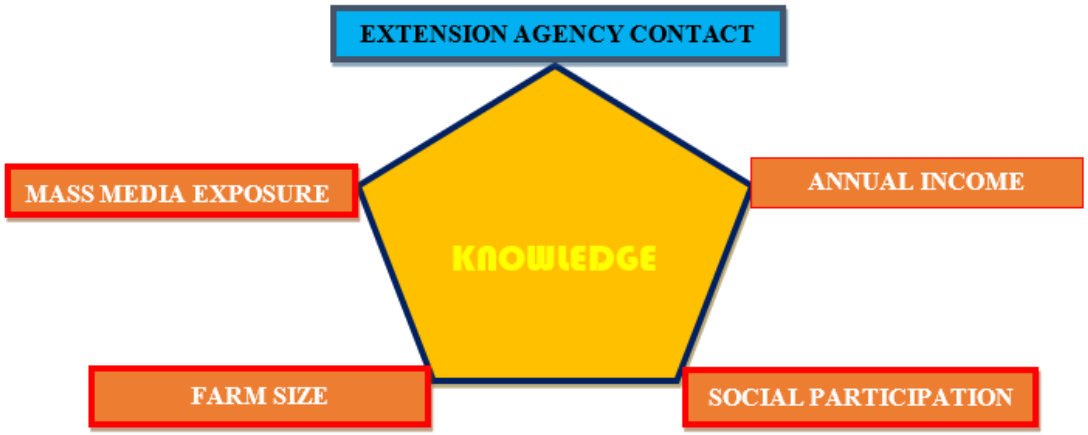

Fig. 1. Empirical model of Socio-economic and Communication variables displaying their relationship with knowledge level on recommended bio-fertilizers practices

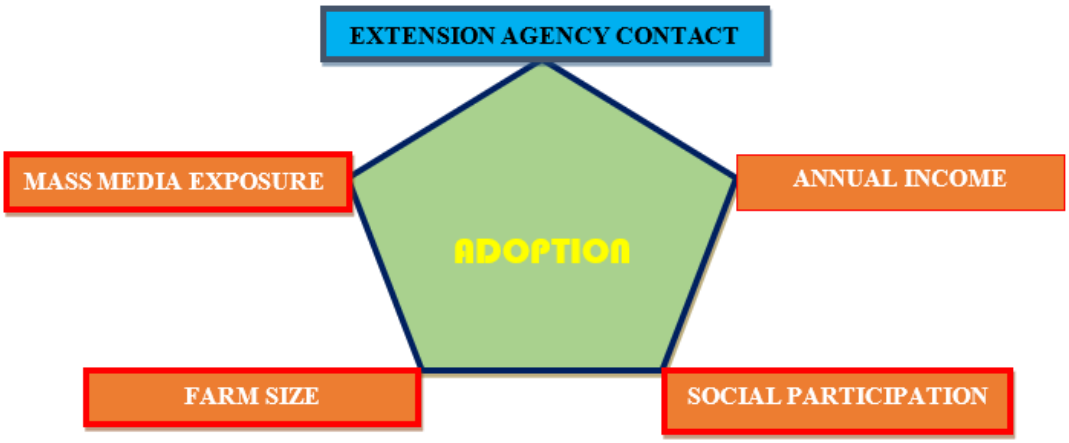

Fig. 2. Empirical model of Socio-economic and Communication variables displaying their relationship with extent of adoption on recommended bio-fertilizers practices

We can see from the Table 3, whereby little under half of the respondents (45.00%) had medium level of social engagement while 33.34 per cent of the participants had a low degree of engagement with society followed by high level (21.66%) of the social participation. The existence of the village cooperative credit society, primary cooperative bank, and cooperative marketing society may be the primary cause of this. The majority of those surveyed were co-operative society members in order to receive their benefits. This result is consistent with Narasimhan's (2014) findings.

Only a small percentage of respondents (20.00%) had high levels of extension agency contact, while the majority (41.66%) had medium levels, followed by low levels (38.34%), as shown in Table 4. The respondents' medium degree of interaction may be primarily due to their infrequent contacts and lack of knowledge about the extension agency. Muthukumar's (2012) findings provide support for this conclusion.

From Table 5, it can be deduced that 45.00 per cent of respondents had medium levels of mass media exposure, followed by 33.33 per cent with low levels and 21.67 per cent with high levels. Illiteracy and the elderly to middle-aged demographic may be the likely causes of that. The findings of Aitochopi (2016) provide support for this conclusion.

Association between socioeconomic and communication factors with their degree of acceptance and understanding of the best practices for bio-fertilizers in paddy farming: To ascertain the relationship between the respondents' profile attributes and their degree of knowledge and adoption of bio-fertilizer procedures in paddy farming, the researcher performed regression and correlation analyses. While regression analysis revealed the most significant variables that predicted the level of adoption, correlation analysis assisted in evaluating the degree of association between individual characteristics belonging to socioeconomic and communication variables with their knowledge and adoption. Thus, the contribution of each variable to adoption behaviour, as well as the direction and intensity of correlations were provided by these statistical tools.

Only one variable, Extension agency contact (X_5), showed a positive relationship at the 05.00 per cent significance level, as shown in table 6 and figure 1 above. In contrast, correlation and regression analysis revealed non-significant values for the other variables, annual income, farm size, social participation, and mass media exposure. Engagement with extension organizations was positively and significantly correlated with the level of knowledge of paddy farmers. This implies that regular interactions with extension specialists facilitated farmers' access to crucial information and encouraged them to use the recommended bio-fertilizers practices. This observation aligns with Sathishkumar's (2016) findings.

Only one variable, Extension agency contact (X_5), showed a positive relationship at the 05.00 per cent significance level, as shown in table 7 and figure 2 above. In contrast, correlation and regression analysis revealed non-significant

Table 4. Distribution of respondents according to their Extension agency contact

Sl. No.	Category	No. of respondents	Per cent
1.	Low	46	38.34
2.	Medium	50	41.66
3.	High	24	20.00
Total		**120**	**100.00**

Table 5. Distribution of respondents according to their level of Mass media exposure

Sl. No.	Category	No. of respondents	Per cent
1.	Low	40	33.33
2.	Medium	54	45.00
3.	High	26	21.67
Total		**120**	**100.00**

Table 6. Multiple Regression and Zero-order Correlation of Paddy Farmers' Socioeconomic and Communication Factors with Their Understanding of Suggested Bio-fertilizers Adoption

S. No.	Category of Variables	Variables	'r' Value	Regression Co-efficient	Standard error	't' Value
X_1	Socio-economic Variables	Annual income	-0.102 NS	0.477	0.311	1.433 NS
X_2		Farm size	0.012 NS	0.105	0.090	1.161 NS
X_3	Communication Variables	Social participation	0.125 NS	0.767	1.039	0.739 NS
X_4		Extension agency contact	0.199*	0.649	0.317	2.058*
X_5		Mass media exposure	0.067 NS	0.035	0.038	0.785 NS

*** - Significant at 1 per cent level of probability.* $R^2 = 0.547$
** - Significant at 5 per cent level of probability.* $F = 6.478^{**}$
NS - Non-significant

Table 7. Multiple regression showing zero-order correlation between paddy farmers' socioeconomic and communication factors and the degree to which they use recommended bio-fertilizers practices

S. No.	Category of Variables	Variable	'r' Value	Regression Co-efficient	Standard error	't' Value
X_4	Socio-economic Variables	Annual income	-0.103 NS	0.519	0.409	1.275 NS
X_5		Farm size	-0.017 NS	0.107	0.093	1.188 NS
X_7	Communication Variables	Social participation	0.057 NS	-1.722	2.468	-0.694 NS
X_9		Extension agency contact	0.189*	2.794	1.137	2.158*
X_{11}		Mass media exposure	0.064 NS	0.046	0.096	0.466 NS

*** - Significant at 1 per cent level of probability.* $R^2 = 0.521$
** - Significant at 5 per cent level of probability.* $F = 6.161^{**}$
NS - Non-significant.

values for the other variables, annual income, farm size, social participation, and mass media exposure. Paddy farmers' contact with extension agencies was positively and significantly connected with their level of expertise, suggesting that more interaction with extension

specialists facilitated the adoption of recommended bio-fertilizers techniques.

4. Conclusion

Extension agency contact was found to be a key factor of paddy farmers' understanding and implementation of suggested bio-fertilizer methods. Therefore, encouraging the use of sustainable bio-fertilizers can be greatly aided by strengthening extension networks through field demonstrations, mobile-based advisories, and participatory training programs.

To increase adoption and guarantee long-term paddy productivity, it is crucial to set up decentralized bio-fertilizers delivery units, provide incentives for environmentally friendly inputs, and integrate extension services with neighbourhood organizations. While the remaining socio-economic and communication variables showed non-significant connections with farmers' knowledge and adoption levels, the hypothesis (H_1) regarding only one variable called extension agency contact (X_4) in the communicative variables was accepted at the 5% level of probability.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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