

International Journal of Agriculture Extension and Social Development

Volume 9; Issue 4; April 2026; Page No. 463-465

Received: 09-02-2026
Accepted: 11-03-2026

Indexed Journal
Peer Reviewed Journal

Drivers of seed demand among rice farmers of Kerala: A principal component regression analysis

¹Shuhaib M and ²Darsana S

¹M.Sc. Scholar, Department of Agricultural Extension, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur, Kerala, India

²Assistant Professor, Department of Agricultural Extension, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur, Kerala, India

DOI: <https://www.doi.org/10.33545/26180723.2026.v9.i4f.3504>

Corresponding Author: Shuhaib M

Abstract

Understanding the factors that drive seed demand is crucial for optimizing agricultural extension services and ensuring seed security. This study investigates the drivers of seed demand among rice farmers in the Palakkad and Wayanad districts of Kerala, India. Utilizing an ex-post facto research design, data was collected from 60 randomly selected rice farmers. Principal Component Analysis (PCA) was employed for data reduction, followed by an Ordinary Least Squares (OLS) Principal Component Regression (PCR) to quantify the influence of institutional, environmental, sociocultural, technological, infrastructural, and economical drivers. The results indicate that economical factors (standardized beta = 0.616, $p < 0.001$) are the strongest predictors of seed demand, followed by environmental (standardized beta = 0.481) and sociocultural (standardized beta = 0.479) drivers. Infrastructural drivers were found to be non-significant. The findings highlight the necessity of targeted financial support and agro-ecologically suitable seed provisions to sustain modern rice farming systems.

Keywords: Seed demand, Rice farmers, Principal component regression, Seed demand drivers

1. Introduction

Rice is extensively cultivated all over Kerala and it remains as the primary staple food grain in the state. Over the years, rice farmers in Kerala started using quality seeds acquired from formal sources (Scholey and Padmanabhan, 2017) ^[13]. To ensure reliable germination rates and maintain overall crop productivity, the periodic replacement of saved seeds with fresh stock of certified and quality assured seeds remains essential for farmers (McGuire & Sperling, 2016) ^[11]. Sustaining a consistent seed demand is therefore a necessary condition for the viability of formal, market-dependent seed systems prevalent in the state. Ultimately, understanding the multidimensional factors that drive this demand is crucial for optimizing agricultural extension services and ensuring long-term seed security. To effectively quantify the various factors influencing seed demand, it is essential to categorize the selected indicators theoretically into distinct dimensions and evaluate them. This study aims to isolate and analyze the specific institutional, environmental, sociocultural, technological, infrastructural, and economical drivers that dictate the seed demand of rice farmers in Kerala's major rice-producing districts.

2. Methodology

2.1 Research Design and Location

An ex-post facto research design was utilized for this study, as the events had already occurred, and the researcher had

no direct control over the variables to manipulate them. The study was conducted in the State of Kerala. To capture diverse agro-ecological and socio-economic dynamics, Palakkad and Wayanad districts were selected.

2.2 Sample and Sampling Procedure

A total of 60 farmers were randomly selected for the study. The sample comprised 30 farmers from Palakkad and 30 farmers from Wayanad. The respondents were distributed across blocks with significant areas under rice, such as Sulthan Bathery in Wayanad, and Alathur and Kuzhalmannam in Palakkad (Kerala State Planning Board, 2024) ^[9]. A proportionate sampling based on the total area under rice production in the panchayats in these blocks were carried out.

2.3 Selection and Measurement of Variables

Primary data was collected through structured personal interviews. Secondary data was collected from government reports, research studies, and other published data sources. MS-Excel and IBM SPSS Statistics for Windows, Version 31.0 was used for the analysis of collected data. Drivers of seed demand under various domains viz. institutional, environmental, sociocultural, technological, infrastructural, and economical were selected for the study based on literature review and expert judgment. Data collection utilized multiple measurement formats depending on the variable. Categorical responses were captured using binary

indicators, while perceptual and behavioral variables were measured using 3-point and 7-point Likert scales. For analytical purposes, continuous variables, including total input costs, were subsequently classified into discrete categories using quartile deviation. Seed demand was operationalized mathematically to represent the requirement in kilograms per year. The equation used was:

$$\text{Seed demand } Sa = (AxTs)/Tr \text{ (Kansiime et al., 2017) [8]}$$

Where:

Sa = Seed demand in kg per year

A = Area planted

Ts = Seed rate

Tr = Seed renewal period (in years)

2.4 Data Reduction and Principal Component Regression (PCR)

To prevent multicollinearity and manage multiple survey statements, Principal Component Analysis (PCA) was applied independently to each predefined dimension of drivers. Prior to extracting the first Principal Component (PC1), data suitability was evaluated using the Kaiser-Meyer-Olkin (KMO) Measure of sampling adequacy and Bartlett's test of sphericity. The extraction criteria retained components with an eigenvalue greater than 1.0, ensuring PC1 explained the absolute majority of the variance. According to Hair et al., (2018) [6], extracting a component that explains 50% to 60% of the total variance is considered highly satisfactory and statistically robust.

The generated standardized PC1 factor scores were then used as the sole independent predictor variable in an Ordinary Least Squares (OLS) regression model. Because of the skewness observed in seed demand, the dependent variable was log-transformed. The predictive equation was specified as:

$$Y_i = \beta_0 + \beta_1(PC1_i) + \epsilon_i$$

Where Y_i is the dependent variable (Seed demand) for the i -th farmer, β_0 is the intercept, β_1 is the unstandardized regression coefficient for the PC1 index, $PC1_i$ is the standardized factor score, and ϵ_i is the stochastic error term.

3. Results and Discussion

3.1 Socio-Economic Profile of Farmers

The demographic data revealed that the majority of rice farmers in Palakkad (60.00%) and Wayanad (56.67%) belonged to the middle-age category (45–59 years). Educationally, half of the Palakkad sample (50.00%) and a majority in Wayanad (56.67%) possessed a high school education. Agriculture served as the sole source of income for 86.67% of farmers in Palakkad and 76.67% in Wayanad. Farming experience was notably high, with 80.00% of Palakkad farmers falling into the medium-experience (15–30 years). Cultivation scale primarily ranged between 0.4 and 1.0 Hectares (80.00% in both districts). Notably, 100.00% of in Palakkad and 96.67% in Wayanad utilized conventional, non-organic farming methods. Financially, farmers often required external support, with 53.33% in Palakkad relying on a combination of their own funds and credit to manage higher input costs.

3.2 Distribution of Seed Demand

The study observed the cultivation of several improved variety seeds among the sampled groups. In Wayanad, farmers primarily cultivated Uma, Pournami, IR20, Kanchana, Jyothi, Athira, Jaya, and IR8. In Palakkad, the varieties predominantly included Uma, Jyothi, Kanchana, and Deepthi. Descriptive statistics indicated that the seed demand for rice varieties was positively skewed, exhibiting a skewness of 0.87.

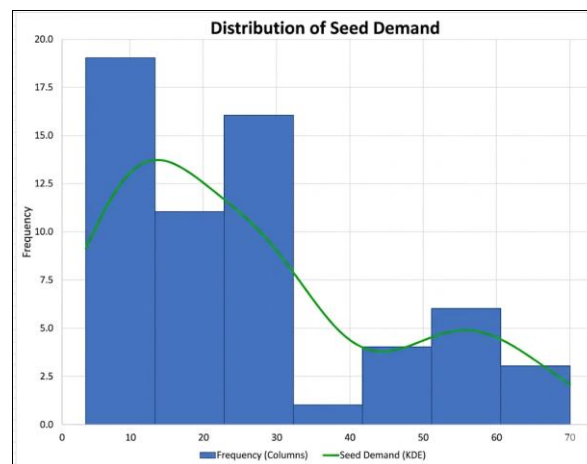


Fig 1: Distribution of seed demand against frequency of farmers

3.3 Diagnostic Tests and PCA Extraction

PCA was conducted separately for institutional, environmental, sociocultural, technological, infrastructural, and economical drivers among the 60 farmers. These drivers of seed demand were selected. The KMO measures and Bartlett's test confirmed the data's suitability for most constructs, with PC1 explaining between 27.9% and 69.2% of the total variance. However, infrastructural drivers of demand yielded a KMO of 0.437 (non-significant) and were consequently deemed unsuitable for PCA and PC1 extraction. This could be due to failure of variables under this driver to form a component when a sample group experiences highly uniform or standardized conditions (Franco-Martínez et al., 2022) [3].

Table 1: PCA Diagnostic tests and variance extraction (N=60)

Drivers of seed demand	KMO value	Bartlett's test (p-value)	Total variance explained (PC1)
Institutional	0.752	< 0.001	54.718
Environmental	0.594	< 0.001	64.170
Sociocultural	0.646	< 0.001	67.384
Technological	0.798	< 0.001	56.743
Infrastructural	0.437	0.459 (ns)	27.964
Economical	0.618	< 0.001	57.667

Note: *** $p < 0.001$: Significant at 0.1% significance level.

3.4 Principal Component Regression (PCR) of seed demand drivers

Table 2: Regression statistics of drivers of seed demand (N=60)

Drivers of seed demand	Standardized Beta	Adjusted R ²	p-Value
Institutional	0.359	0.120	< 0.001 ***
Environmental	0.481	0.224	< 0.001 ***
Sociocultural	0.479	0.219	< 0.001 ***
Technological	0.368	0.126	< 0.001 ***
Economical	0.616	0.371	< 0.001 ***

Economical Drivers: Economical drivers had the strongest positive influence on seed demand for farmers (standardized beta = 0.616, adjusted $R^2 = 0.371$, $p < 0.001$). The primary factors driving this were financial support from schemes (loading = 0.826) and gross income from paddy (loading = 0.682), weighed against the negative loading of input costs like fertilizers and chemicals. The negative loading could be due to high input efficiency of crops reported by farmers who follow comparatively more seed replacement. Similar result was given by Gautam *et al.* (2023) ^[4]. Positive influence of agricultural subsidies and institutional financial support on seed demand was supported by Holden (2019) ^[7] and gross income by Foster & Rosenzweig (2010) ^[12].

Environmental Drivers: Environmental factors were the second most significant determinants, with a standardized beta of 0.481 (adjusted $R^2 = 0.224$, $p < 0.001$). Among farmers, the frequency of drought (loading = 0.816), low input requirement (loading = 0.758), and agro-ecological suitability (loading = 0.636) were major loadings dictating seed choice and volume. Similar results were given by Steinke *et al.* (2023) ^[14] and Minot *et al.* (2007) ^[12].

Sociocultural Drivers: Sociocultural drivers also exerted a high influence (standardized beta = 0.479, adjusted $R^2 = 0.219$, $p < 0.001$). The seed demand in this cohort was highly influenced by the opinions of peers, including neighbors (loading = 0.877) and friends (loading = 0.848), alongside general community acceptance (loading = 0.731). This result was supported by findings of Takahashi *et al.* (2020) ^[15] and Maertens (2017) ^[10].

Technological Drivers: Technological factors served as significant predictors (standardized beta = 0.368, adjusted $R^2 = 0.126$, $p < 0.001$). Farmers placed high value on seed quality satisfaction (loading = 0.842), a minimum of off-type seeds (loading = 0.802), and reliable germination rates (loading = 0.763). Positive influence of satisfaction in seed quality with seed demand was supported by findings of studies conducted by Ghimire *et al.* (2015) ^[5], Genetic purity and minimum off-type seeds by Witcombe *et al.* (2016) ^[16] and reliable seed germination by McGuire & Sperling, (2016) ^[11].

Institutional Drivers: Institutional drivers significantly impacted the seed demand among farmers (standardized beta = 0.359, adjusted $R^2 = 0.120$, $p < 0.001$). The crucial components within this driver included trust in krishi bhavan promoted seeds (loading = 0.820), the availability of low-cost quality seeds (loading = 0.786), quality assurance (loading = 0.727), and subsidy provisions (loading = 0.621). Similarly, the influences of positive institutional factors like provision of quality assurance in driving seed demand were given by Almekinders *et al.* (2019) ^[1].

Conclusion

The analysis of drivers of seed demand among rice farmers in Kerala underscores a highly structured and market-dependent seed system and demand structure. Economical and institutional drivers are powerful determinants of seed demand, highlighting their reliance on formal markets, institutional credit, and subsidized, low-cost quality seeds. Furthermore, environmental suitability and sociocultural peer especially friends and neighbors influence play critical roles in defining the volume and type of seeds procured.

Agricultural extension strategies aiming to promote seed replacement of different rice varieties specifically being cultivated in an area must therefore prioritize economic viability, specifically managing high cost requirements, while ensuring the genetic purity and agro-ecological resilience of the seeds provided by institutional sources for better outcomes.

References

1. Almekinders CJM, Walsh S, Jacobsen KS, Andrade-Piedra JL, Bèye CG, Pelulessy W, *et al.* Why interventions in the seed systems of roots, tubers and bananas crops do not change the practices of smallholder farmers. *NJAS-Wageningen Journal of Life Sciences*. 2019;88:87-95.
2. Foster AD, Rosenzweig MR. Microeconomics of technology adoption. *Annual Review of Economics*. 2010;2:395-424. Franco-Martínez A, Alvarado JM, Sorrel MA. Range restriction affects factor analysis: normality, estimation, fit, loadings, and reliability. *Educ Psychol Meas*. 2022;83(2):262-293.
3. Gautam D, Dhakal SC, Kattel RR, Khanal NK. Strengthening the competitiveness of the lentil seed system of Nepal: a value chain approach. *J Agribus Rural Dev*. 2023;67(1):63-77.
4. Ghimire R, Huang WC, Shrestha RB. Factors affecting adoption of improved rice varieties among rural farm households in Central Nepal. *Rice Sci*. 2015;22(1):35-43.
5. Hair JF, Black WC, Babin BJ, Anderson RE. *Multivariate data analysis*. 8th ed. Cengage Learning; 2018. 832 p.
6. Holden ST. Economics of farm input subsidies in Africa. *Annu Rev Resour Econ*. 2019;11:501-522.
7. Kansime MK, Karanja DK, Alokith C, Ochieng J. Derived demand for African indigenous vegetable seed: implications for farmer-seed entrepreneurship development in Uganda. *Int Food Agribus Manag Rev*. 2018;21(6):723-739.
8. Kerala State Planning Board. *Economic review 2023*. Vol. 1. Government of Kerala; 2024. 654 p.
9. Maertens A. Who cares what others think? Social learning and social pressures in cotton farming in India. *Am J Agric Econ*. 2017;99(4):988-1007.
10. McGuire S, Sperling L. Seed systems smallholder farmers use. *Food Secur*. 2016;8(1):179-195.
11. Minot N, Smale M, Eicher C, Jayne T, Tarr J, Blackie M, *et al.* *Seed sector in Sub-Saharan Africa: issues and options*. World Bank; 2007. 82 p.
12. Schöley M, Padmanabhan M. Formal and informal relations to rice seed systems in Kerala, India: agrobiodiversity as a gendered social-ecological artifact. *Agric Hum Values*. 2017;34:969-982.
13. Steinke J, Ortiz-Crespo B, van Etten J, Borman GD, Hassena M, Kretschmer M, *et al.* Seasonal seed scenario planning: co-design of a generic framework for matching seed supply and demand using seasonal climate forecasts. *Clim Serv*. 2023;32:100410.
14. Takahashi K, Muraoka R, Otsuka K. Technology adoption, impact, and extension in developing countries' agriculture: a review of the recent literature. *Agric Econ*. 2020;51(1):31-45.
15. Witcombe JR, Virk DS, Farooq M. Improving seed quality and genetic purity for commercial agriculture. *J Crop Improv*. 2016;30(4):381-405.