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RESEARCH PAPER

Determinants of adoption and constraints faced by farmers using nano urea plus in soybean production in Haveri district of Karnataka

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Abstract: Soybean (*Glycine max* L.) is a major oilseed crop that contributes significantly to farmers' income and plays a vital role in India's agricultural economy. In the year 2024-25, the study was undertaken to investigate the factors influencing the adoption of nano urea plus and to identify the major constraints faced by sample farmers using nano urea plus and conventional urea in Haveri district of Karnataka. The primary data was collected from soybean growers. The results of the study revealed that the age had a negative coefficient value (-0.6012) which was statistically significant at 5 per cent level of probability. The odds ratio analysis indicated that subsidy availability increased the likelihood of adoption by 5.53 times. The availability of subsidies had the highest marginal effect at 0.5582 which showed that access to subsidies increased the probability of adoption by 55.82 per cent. The results of Garrett's ranking techniques analysis showed that the most severe constraint identified was difficulty in the requirement of equipment for application of nano urea plus which has ranked first with the highest Garrett mean score of 64.50.

Key words: Conventional urea, Nano urea plus, Soybean, Subsidy

Introduction

Soybean (*Glycine max* L. Merrill) is one of the most important oilseed crop grown worldwide and is often referred to as the "Golden Bean" due to its high protein content, versatility and contribution to food security. In India, soybean plays a crucial role in farmers' income generation and is a key component of crop rotations in major states such as Madhya Pradesh, Maharashtra and Karnataka. Efficient nutrient management is a major determinant of soybean productivity, as the crop is highly responsive to nitrogen application. Conventional urea has long been the primary nitrogen source; however, its low nitrogen use efficiency (30-40%), susceptibility to leaching and volatilization losses and high input requirement pose challenges for sustainable production (Upadhyay *et al.,* 2023). Excessive use of urea, often encouraged by subsidies, also leads to soil health deterioration, ground water contamination and green house gas emissions. Therefore the application of nano urea plus offers promising alternative to conventional urea due to precise nitrogen delivery and low environmental impact. Its nano-scale size ensures higher foliar absorption and improved nitrogen use efficiency, thereby reducing the quantity of nitrogen fertilizer needed per hectare. The adoption of such innovative technology can lower production costs, enhance yield and contribute to environmental sustainability. Despite these potential benefits, the adoption rate of nano urea plus among soybean farmers remains moderate and its diffusion is influenced by several socio-economic, psychological and institutional factors. Understanding the determinants of adoption behaviour is essential for policymakers to design interventions that promote wider use of nano urea plus. With this background the researcher undertook the study during 2024-25 to identify the significant factors influencing adoption of nano urea plus and explores constraints faced by sample farmers using nano urea plus and conventional urea in Haveri district of Karnataka.

Material and methods

Haveri district was purposively selected and the two taluks (Ranebennur and Hirekerur) based on opinion of experts of IFFCO officials that Haveri district is the highest area under application of nano urea plus and also found to be one of the good consumers of nano urea plus fertilizer. From each taluk, two villages selected purposively again based on the highest area under application of nano urea plus fertilizer. At village level, 15 farmers using nano urea plus and 15 farmers using conventional urea were selected by purposive random sampling technique.

The present study used primary data which were collected from farmers through personal interview method with pretested and well-structured schedule specifically designed for the study.

Descriptive statistics, Logit regression model and Garrett ranking technique were worked out in the study.

Logit regression model

The factors influencing the adoption of nano urea plus in soybean cultivation were studied using the logit model. Farmers decisions 'to adopt' or 'not to adopt' are of discrete or qualitative (such as 'yes' or 'no') in nature, where the dependent variable is of 'binary choice' (Like yes = 1, no=0) or truncated with a sudden jump in the value from the zero (like 0, 1000, 2000..), we cannot use the usual ordinary least square' (OLS)

procedure in studying the functional relationship between dependent and the independent variables as it takes nonlinear form. In such cases a special estimation technique known as 'maximum likelihood estimation' (MLE) will be used by constructing the qualitative choice models (Pindyck and Rubinfeld, 1991). The logit model used in the study is discussed briefly below.

Let

$$Yi = \begin{cases} 1 \text{ If farmer adopted nano urea plus} \\ 0 \text{ Otherwise} \end{cases}$$

The logistic regression (logit model) expresses the probability of adoption P_i as:

$$Pi = Pr(Yi = 1) = \frac{e\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots\ldots + \beta_k X_{ki}}{1 + e\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + + \ldots\ldots\ldots + \beta_k X_{ki}}$$

Or equivalently, in log-odds (logit) form:

$$In = \left(\frac{1-P_i}{P_i}\right) \quad \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots\ldots + \beta_k X_{ki}$$

Where

Pi = probability that the i^{th} farmer adopts nano urea plus

X_{1i}, X_{2i},…,X_{ki} = explanatory variables (factors influencing adoption)

β_0, β_1,…, βk= parameters to be estimated

Garrett ranking technique

Identification of constraints faced by the farmers using nano urea plus and conventional urea in soybean production is one of the important aspects of research. The respondents were asked to rank (in the order) the constraints in lack of equipment requirement for spray and climatic variability *etc* these ranks were converted to scores by referring to Garrett'stable. The order given by the respondents was changed into ranks by using the formula:

$$\text{Per cent position} = \frac{100 \text{ x } (R_{ij} - 0.50)}{Nj}$$

Where,

R_{ij} = rank given for i^{th} item by j^{th} individual

N_j = number of items ranked by j^{th} individual

The percent position of each rank was converted to scores by referring to table given by Garrett and Woodworth (1969). Then for each factor, the scores of individual respondents were summed up and divided by the total number of respondents for whom scores were gathered.

Results and discussion

Table 1, presents socio-economic profile of sample farmers. The average age and family size of farmers using nano urea plus was higher than farmers using conventional urea. The average size of landholding was marginally higher in case of nano urea plus users (5.76 ha) than conventional urea users (5.44 ha). Similarly, average area under soybean per farm was greater in case of nano urea plus users (3.28 ha) compared to conventional urea users (2.93 ha).

Selection of variables and their meaning for logit model

Variables included in the logit model was presented in Table 2. The variables such as age, education, farm experience, farming experiences and farm size were continuous and quantitative in nature. Whereas, other variables like perceived yield improvement, access to credit, availability of technical guidance, ease of application, cooperative/ group membership and subsidy availability are taken as binary variables for the analysis. The dependent variable, adoption of nano urea plus in soybean production was regressed against the stated independent variables.

Logistic regression coefficients of factors influencing the adoption of nano urea plus

The logistic regression analysis was identified the factors influencing the adoption of nano urea plus among farmers in the study area as presented in Table 3. Among all the variables, age has a negative value (-0.6012) and statistically significant at the 5 per cent level of probability. This result aligning with findings by Khan *et al.,* (2023) noted younger farmers' adaptability to new technologies are more. Subsidy availability

Table 1. Socio-economic profile of the sample farmers

Particulars	Farmers using nano urea plus (n=60)	Farmers using conventional urea (n=60)
Average age (years)	40	45
Average family size (No.)	5	6
Average size of landholding	5.76	5.44
Average area under soybean per farm (ha)	3.28	2.93

Table 2. Selection of variables and their meaning for logit model

Variable	Description	Type	Expected Sign
Age (X_1)	Age of the farmer (years)	Continuous	-
Education level (X_2)	Years of formal schooling completed	Continuous	+
Farming experience (X_3)	Length of time spent in cultivating (Years)	Continuous	+
Farm size (X_4)	Total landholding (ha)	Continuous	+
Perceived yield improvement (X_5)	1 = Yes, 0 = No	Binary	+
Access to credit (X_6)	1 = Yes, 0 = No	Binary	+
Availability of Technical Guidance (X_7)	1 = Available, 0 = Not available	Binary	+
Ease of Application (X_8)	1 = Easy, 0 = Not easy	Binary	+
Cooperative / Group membership (X_9)	1 = Member, 0 = Not a member	Binary	+
Subsidy Availability (X_{10})	1 = Received subsidy, 0 = No subsidy	Binary	+

Table 3. Logistic regression coefficients of the factors influencing the adoption of nano urea plus

Factors	Coefficients	Standard error	Z value
Age (X_1)	-0.6012**	0.2314	-2.5980
Education level (X_2)	1.2022*	0.5501	2.1858
Farming experience (X_3)	0.1255	0.6412	0.1957
Farm size (X_4)	0.2790	0.5929	0.4705
Perceived yield improvement (X_5)	1.9217***	0.5838	2.7162
Access to credit (X_6)	0.2971	0.6012	0.4941
Availability of technical guidance (X_7)	0.1923	0.3990	0.4819
Ease of application (X_8)	1.7248**	0.5960	2.8937
Cooperative / Group membership (X_9)	0.8912	0.5234	1.7027
Subsidy availability (X_{10})	2.1127***	0.5800	3.6425
Null deviance	159.24 on 119 degrees of freedom		
Residual deviance	89.15 on 110 degrees of freedom		
AIC	107.15		

Note: ***Significant at one per cent level of probability
**Significance at five per cent level of probability
*Significance at ten per cent level of probability

Table 4. Odds ratio of the logit regression coefficients of factors influencing the adoption of nano urea plus

Factors	Odds ratio	2.5% (CI lower)	97.5% (CI Upper)
Age (X_1)	0.5482	0.3493	0.8607
Education level (X_2)	3.0274	1.0322	8.7762
Farming experience (X_3)	1.1337	0.3248	3.9569
Farm size (X_4)	1.3218	0.4148	4.2113
Perceived yield improvement (X_5)	4.2245	1.3725	13.5444
Access to credit (X_6)	1.3459	0.4112	4.4053
Availability of technical Guidance (X_7)	1.2129	0.5535	2.6511
Ease of application (X_8)	3.9114	1.2638	12.8490
Cooperative / group membership (X_9)	2.4381	0.8795	6.7587
Subsidy availability (X_{10})	5.5341	1.7735	17.5936

has the strongest influence on adoption with the highest coefficient of 2.1127 and statistically significance at the 1 per cent level. This indicated that access to subsidies greatly encourages the adoption of nano urea plus and this making it more economically feasible for farmers.Other variables like farming experience (0.1255), farm size (0.2970) and availability of technical guidance (0.1923) showed positive but statistically insignificant which indicating that they were not played a strong role in adoption in the study area.The model showed good fit with deviance reducing from 159.24 to 89.15 and an AIC value of 107.15.

Odds ratio of factors influencing the adoption of nano urea plus

Table 4 presents the odds ratios derived from the logistic regression model. The odds ratio for age was 0.5482, with a confidence interval ranging from 0.3493 to 0.8607. This value is less than 1 and statistically significant which indicating that with increasing age, the probability of adopting nano urea plus decreases. The strongest predictor among all variables is subsidy availability with an odds ratio of 5.5341. This finding clearly showed that farmers who have access to subsidies are over five times more likely to adopt nano urea plus than those who do not access to subsidies. This finding aligning with Ramappa *et al.,* (2016) highlighted subsidies act as adoption drivers. Access to credit and availability of technical guidance have odds ratios of 1.3459 and 1.2129, respectively but both have confidence intervals that include 1 which indicating that while they may facilitate adoption but their influence is not statistically significant in this analysis.

Constraints faced by sample farmers using nano urea plus in soybean production

Table 5 presents the major constraints faced by sample farmers using nano urea plus (NUP) in soybean production. The most severe constraint identified was difficulty in the requirement of equipment for application of NUP which has ranked first with the highest Garrett mean score of 64.50. This result aligning with Yadav and Sharma (2019) identified equipment shortages as a major barrier to nano-fertilizer adoption and followed by limited awareness and knowledge about nano urea plus especially among small and marginal farmers (63.50), Lack of effective field demonstrations (60.00), Lack of proper training or guidance on usage (53.25). Lastly, difficulty in correct application or dosage was the least significant constraint with the lowest Garrett mean score of 31.33 suggested that once initial awareness and training are addressed, technical handling may not be a major issue.

Constraints faced by sample farmers using conventional urea in soybean production

Table 6 presents the major constraints faced by farmers using conventional urea in soybean production as determined through Garrett's ranking technique. The most critical issue reported was losses due to volatilization/leaching which was ranked first with highest Garrett's mean score of 70.67. This result align with Agarwal and Singh (2015) findings reported significant nitrogen loss with conventional urea in soybean cultivation because conventional urea is highly prone to nitrogen losses under field conditions and followed by excessive use of urea due to subsidy (68.00), lack of awareness about integrated nutrient management (62.17). Lastly, storage and handling problems were the least ranked constraint among the

Table 5. Constraints faced by sample farmers using nano urea plus in soybean production

Constraint	Garrett's mean score	Rank
Difficulty in requirement of equipment for application of nano urea plus	64.50	I
Limited awareness & knowledge about nano urea plus among small and marginal farmers	63.50	II
Lack of effective field demonstrations	60.00	III
Lack of proper training or guidance on usage	53.25	IV
Lack of trust in effectiveness among farmers	51.83	V
Not effective as sole source of nitrogen for all crops	52.16	VI
Perceived lower yield compared to conventional urea	36.83	VII
Difficulty in correct application/ dosage	31.33	VIII

Table 6. Constraints faced by sample farmers using conventional urea in soybean production

Constraint	Garrett's mean score	Rank
Losses due to volatilization/leaching	70.67	I
Excessive use of urea due to subsidy	68.00	II
Lack of awareness about integrated nutrient management	62.17	III
Increased pest and disease incidence due to imbalanced use	59.17	IV
Misapplication due to lack of technical guidance	35.78	V
Need for large quantity compared to NUP	31.32	VI
Storage and handling problems	27.83	VII

respondents with a lowest Garrett mean score of 27.83. While this suggested that storage and handling challenges are not significant barrier.

Conclusions

The farmer decision to adopt nano urea plus in soybean production is significantly influenced by factors such as availability of subsidy (Odds ratio = 5.53), ease of application (Odds ratio = 3.91) and perceived yield improvement (Odds ratio = 4.22), as evidenced by logistic regression. However, challenges such as equipment requirement for spraying, limited awareness and inadequate training are the major issues faced by nano urea plus users. In contrast, conventional urea users face issues like nitrogen losses and excessive application due to subsidies *etc*. Therefore, to accelerate adoption of nano urea plus and increasing farmers' confidence, it is essential to educate farmers regarding advantages of nano urea plus through different initiatives from institutions like IFFCO, State Agriculture Department, SAU, KVK *etc.*

References

Agarwal P K and Singh O P, 2015, An economic analysis of soybean cultivation in Ratlam district of Madhya Pradesh, India. *Indian Journal of Agricultural Research*, 49(4): 308 - 314.

Anand Kumar Pathak and Kevin Christopher, 2018, Study of socio-economic condition and constraints faced by the farmers in adoption of bio fertilizer in Bhadohi district (Uttar Pradesh). *Journal of Pharmacognosy and Phytochemistry,* 8(2): 1916-1917.

Bhagyamma S and Bhat A R S, 2019, Socioeconomic factors affecting adoption of recommended dose of fertilizer (RDF) in Karnataka state. *Plant Archives,*19(1): 1248-1252.

Garett Herry and P S Wood Worth, 1969, Statistics in psychology and education, Bombay vakils fitter and sciences publishing agency, Bombay, India, pp. 329.

Islam M K and Hossain M E, 2016, Factors affecting the adoption decision of high doses of chemical fertilizer and pesticide in agriculture in Rangpur district of Bangladesh. *International Journal of Management and Economics Invention*, 2(7): 681-689.

Khan H, Manavi K, Singh K and Pauj Sarvana, 2023, Climate Risks in Indian Agriculture. *Climate Change Studies,* 15(2): 99-114.

Pindyck R S and Rubinfeld D L, 1991, Econometric models and economic forecasts, McGraw Hill publishers, USA.

Ramappa K B, Kannan E and Lavanya B T, 2016, Adoption of recommended doses of fertilisers on soil test basis by farmers in Karnataka. *Agricultural Situation in India*, 76(2): 25-29.

Upadhyay P K, Singh V K, Rajanna G A, Dwivedi B S, Dey A, Singh R K, Rathore S S, Shekhawat K, Babu S, Singh T and Kumar Y, 2023, Unveiling the combined effect of nano fertilizers and conventional fertilizers on crop productivity, profitability and soil well-being. *Frontiers in Sustainable Food Systems*, 7(2): 126-132.

Yadav S and Sharma T, 2019, Equipment constraints in nano-fertilizer adoption. *Journal of Agricultural Engineering*, 56(3): 78-90.