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A probit analysis of factors influencing adoption of UASB released VCF-0517 sugarcane variety in southern dry zone of Karnataka

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Abstract

The All India Coordinated Research Projects (AICRPs) have significantly advanced agricultural research in India since 1970, focusing on developing innovations tailored to various agro-climatic conditions. The AICRP on sugarcane, established in 1972 at the Zonal Agricultural Research Station (ZARS), Mandya, under the umbrella of University of Agricultural Sciences, Bengaluru (UASB), has been pivotal in creating improved sugarcane varieties. A notable achievement is the development of the VCF-0517 sugarcane variety, known as "Bahubali," for its high yield and drought tolerance, now covering over 75% of the sugarcane area in South Karnataka. This study examined the socio-economic factors influencing the adoption of VCF-0517 sugarcane variety. The study found that younger farmers are more likely to adopt the UASB sugarcane variety VCF-0517, with age inversely affecting adoption by 40.20 percent. Education level positively influenced adoption of VCF-0517 sugarcane. These findings suggest that younger and better-educated farmers are more inclined to adopt innovative farming practices. The study also found that, better access to credit and frequent contact with extension services significantly enhance the adoption of VCF-0517 sugarcane among farmers highlight the importance of financial support and effective agricultural outreach in promoting the uptake of new farming innovations.

Keywords: VCF-0517, sugarcane, socio-economic factors, probit model, UAS Bangalore

Introduction

As the global population has surged from 1.6 billion in 1900 to nearly 8 billion today, the increase in arable land has been minimal, rising only slightly from 0.93 to 1.5 billion hectares [1]. This disparity underscores the urgent need to enhance food production and land productivity. Despite the static land resource, agricultural innovations and sustainable practices are crucial for meeting the rising food demands. The COVID-19 pandemic highlighted agriculture's essential role in maintaining food supply amidst global disruptions. Therefore, prioritizing agricultural investment and research is vital for long-term food security.

All India Coordinated Research Projects (AICRPs) on different crops are coordinating research work in the country since 1970 through a network of research stations of ICAR (Indian Council of Agricultural Research), State Agricultural Universities, State Government Departments and Non-Government Organizations [2]. Currently there are 62 AICRPs spread all over India. The main emphasis is laid on the development of new innovations in agriculture such as improved varieties, crop production and protection technologies suited to commercial cultivation under different agro-climatic conditions of the country. However, the research component budget for the SAUs is modest.

The AICRP on sugarcane was established at Zonal Agricultural Research Station (ZARS), V. C. Farm, Mandya in the year 1972. Since its establishment, it has been playing a pivotal role in the development of improved sugarcane varieties, agronomic management practices and plant protection measures for the zone. The CoVC and VCF series verities have been grown widely in the stretches of Cauvery delta which are developed by ZARS, Mandya under the canopy of UAS Bangalore. S. N. Swamy Gowda, a sugarcane breeder from Zonal Agricultural Research Station, Mandya, University of Agricultural Sciences-Bengaluru developed a new sugarcane variety VCF-0517, which is popularly called as "Bahubali" because of its high cane yielding and drought tolerant characters. According to agricultural scientists and breeders, VCF-0517 sugarcane variety was released in 2017 after prolonged research of 11 years by scientists in UAS, Bangalore and it has covered more than 75 percent of area under sugarcane in South Karnataka.

The socio-economic characteristics of farmers, such as age, education level, family size, social participation, loan facility, farm income and land holdings, significantly impact their ability to acquire knowledge and adopt innovative technologies. This study assessed the influence of these socio-economic factors on the adoption of the UASB-released VCF-0517 sugarcane variety using various economic and statistical tools.

Materials and Methods

The Southern dry zone (SDZ) of Karnataka was selected for studying the factors influencing adoption of UASB released VCF-0517 sugarcane variety. The SDZ was selected purposively for the study as major research activities of UASB are based in southern districts of Karnataka and

VCF-0517 sugarcane variety has covered more than 75 percent of area under sugarcane in this zone. The survey was conducted on 100 sample respondents which constitute 50 farmers growing VCF-0517 sugarcane variety and 50 farmers growing check variety. The details on socio-economic characters were collected from sample farmers for the agriculture year 2020-21 by using pre-tested, structured interview schedule.

Table 1: Area coverage by VCF-0517 sugarcane variety in the study area

Year	Area under sugarcane (ha)	Area under VCF-0517 (ha)
2017	31879	7188 (22.55)
2018	51017	12754 (25.00)
2019	54397	22391(41.16)
2020	57104	31970 (55.99)
CAGR (%)	2.51**	65.23***

Note: 1. *** and ** indicates significance at one percent and five percent probability level, respectively
2. Figure in parentheses indicates percent to the total area under sugarcane

Analytical Framework and Empirical Model

Binary probit model

The current study given our binary choice problem; a probit model representation is adopted for the analysis. Thus, whether a farmer adopt (D = 1) or does not adopts (D = 0) given observable vector of independent variables (X) and unobserved random component (ε); if the errors are assumed iid extreme value, then the probit model with the probability that a farmer will exhibit an action P_i (D) is given by:

$$Pr\ (Yi = 1|xi) = F\ (\beta\ 'xi) = \phi\ (\beta\ 'xi \qquad (1)$$

Where Pr denotes probability, Yi is the binary choice variable representing adoption and Φ is the cumulative distribution function (CDF) of the standard normal distribution. β is a vector of unknown parameters. It is assumed that the latent variable Y* can be specified as follows:

$$Yi^* = \beta 0 + \sum_{n=1}^{n} \beta n\, Xni + ui \qquad (2)$$

$$\text{And } Yi = \begin{Bmatrix} 1\ if\ Yi > 0 \\ 0\ otherwise \end{Bmatrix}$$

Where, xi represents a vector of explanatory variables, u_i is a random disturbance term, n is the total sample size, and β is a vector of unknown parameters to be estimated by the method of maximum likelihood.

Due to the non-linearity of the probit model, the parameters are not necessarily the marginal effects of the various independent variables. The marginal effects of the coefficients are more informative and useful for policy decision-making. To estimate the marginal effect, we differentiate equation (1) with respect to xi.

$$\frac{\partial yi}{\partial xi} = \phi(\beta\ 'xi\ )\ \beta i$$

where ϕ represents the probability density function of the standard normal distribution.

The empirical specification of the probit model for the study of factors influencing adoption of VCF-0517 sugarcane variety is given as follows:

$$Yi^* = \beta 0 + \sum_{n=1}^{10} \beta n\, Xni + vi \qquad (3)$$

Where, Y_i = adoption of VCF-0517 variety (=1 if farmer adopted VCF-0517 sugarcane variety, 0 otherwise; x_1 = Land holding; x_2 = Age; x_3 = Age; x_3 = Family size; x_4= Education level; $x_{5=}$ Farm income; x_6 = Credit use (=1 if credit used, 0 otherwise,); X_7=Extension source (=1 if farmer has extension contract, 0 otherwise). The model is appropriate since it can resolve the problem of heteroscedasticity and satisfies the assumption of cumulative normal probability distribution (Gujarati, 2004)[3].

Results and Discussion

Characteristics of Sample Respondents

The socio-economic profile of farmers growing VCF-0517 and CO-86032 sugarcane varieties are depicted in Table 2. The classification of sugarcane growing farmers according to the age group indicated that majority of farmers growing VCF-0517 (46%) and CO-86032 (52%) belongs to old age group (> 50 years), indicating the traditional area of sugarcane cultivation. Only about eight percent of farmers belonged to young age group (35 years) in case of both VCF-0517 and CO-86032 (check variety) growing farms. The farmers growing VCF-0517 sugarcane were marginally young (46 years) compared to farmers growing check variety (50 years).

Education level of sample respondents revealed that majority of the farmers studied up to PUC (Pre-University course) in case of both VCF-0517 (38%) and check variety (36%) growing farms. It could be also observed that 36 percent of VCF-0517 growing farmers and 34 percent of farmers growing check variety had high school level education. The results also showed that 16 percent farmers VCF-0517 sugarcane had college and above (Degree holders) education level, whereas only six percent farmers growing check variety had degree level education indicating that, farmers with higher education level are innovative in adoption of new technologies in agriculture. It is evident from the results that, all the farmers growing VCF-0517 sugarcane were literates and four percent of farmers growing check variety were illiterates. The literacy level among the two categories of respondents was differed as revealed by the significant value of Chi-square test.

Table 2: Socio-economic characters of sugarcane growing sample farmers, (No.)

Sl. No.	Particulars	VCF-0517		CO-86032		Significance
		No	Percent	No	Percent	
I	**Age (Years)**					
1	Young age (<35)	8	16	8	16	t= -1.60*
2	Middle age (35 to 50)	19	38	16	32	
3	Old age (>50)	23	46	26	52	
	Average	46		50		
II	**Literacy level**					
1	Illiterate	-	-	2	4	χ^2=24.20***
2	Primary	5	10	10	20	
3	High school	18	36	17	34	
4	PUC	19	38	18	36	
5	Degree and above	8	16	3	6	
III	**Family size (No.)**					
1	Small (<5)	22	44	19	38	t= 0.42^{NS}
2	Medium (5-6)	16	32	18	36	
3	Large (>6)	12	24	13	26	
	Average	5.18		5.32		
IV	**Land holding**					
1	Marginal (<2.5 acres)	9	18	16	32	t= 1.53*
2	Small (2.5-5 acres)	27	54	18	36	
3	medium (5-7.5 acres)	10	20	12	24	
4	Large (>7.5 acres)	4	8	4	8	
	Average (ac)	4.09		3.71		
	Irrigated (ac)	3.01	73.75	2.23	60.11	
	Source of irrigation					
	Canal	42	84	38	76	
	Borewell	8	16	12	24	

Note: *** and * indicates significance at one percent and ten percent probability level, respectively

The average size of land holding was higher in case of farmers growing VCF-0517 (4.09 acres) compared to check variety farms (3.71 acres). The difference in average land holding was found to be statistically significant, thus farm size also has influence in the adoption of any new technologies.

In the study area having well connected canal irrigation network, hence relatively higher proportion of area operated by the respondents was under irrigation both in the case of farmers' cultivating UASB released variety (73.75%) and check variety growing farms (60.11%). The canal was found to be source of irrigation for majority of respondents growing UASB released VCF-0517 (84%) and check variety farms (76%) and remaining farmers sourced water from borewell.

Table 3: Summary of variables and their expected signs in probit analysis

Sl. No.	Variables	Expected Sign
01	Land holding	+
02	Age	+/-
03	Family size	-
04	Education level	+
05	Farm income	+
06	Credit use	Dummy (availing credit =1, otherwise =0)
07	Extension service	Dummy (Availing extension service =1 otherwise =0)

The summary of variables and their expected influence on the adoption of the VCF-0517 sugarcane variety is outlined in Table 2. The variables land holding, educational level, farm income, credit use, and extension service are expected to have a positive influence on the adoption of the VCF-0517 variety. Conversely, family size and the age of the farmer are anticipated to have a negative influence on the adoption of this sugarcane variety in the study area. These expectations are based on the understanding that larger landholdings, higher education levels, increased farm income, better access to credit, and more frequent extension services typically encourage the adoption of new agricultural technologies. In contrast, older age and larger family size may act as barriers to adopting such innovations.

Probit estimates of factors determining adoption of VCF-0517 sugarcane

Table 4 presents the results of the binary probit regression coefficients of factors affecting farmers' decision to adopt UASB technology (VCF-0517 variety) in sugarcane cultivation. The independent variable age was measured as continuous variable. The results of the econometric model revealed a statistically significant inverse relationship between age and the adoption of UASB sugarcane variety. This implies that young farmers are more likely to adopt UASB technology (VCF-0517 variety), as they presume to have the character of better risk bearing ability and desire driven by higher income. The marginal effect value for age indicated that a unit increase in the age of the farmer decreases the probability of adoption of VCF-0517 sugarcane by 40.20 percent. This implies that aged farmers may not be easily attracted towards innovations in agriculture and due to want of requisite knowledge for the adoption of any new technologies such as VCF-0517 sugarcane variety.

Table 4: Factors determining adoption of UASB sugarcane variety (VCF-0517), (Dependent variable Y=1 for VCF-0517 variety, otherwise 0)

Variables	Coefficients	P-value	Marginal Probabilities
Land holding	0.123	0.561	0.141
Age	-0.027**	0.019	0.402
Family size	-0.088	0.197	0.144
Education level	0.290*	0.065	0.312
Farm income	0.081	0.385	0.172
Credit use	0.645*	0.055	0.134
Extension service	0.017*	0.095	0.218
Constant	0.400	0.667	
Log likelihood	-55.230		
Pseudo R2	0.203		

Note: ** and * indicates statistical significance at five and ten percent probability level, respectively.

Education level of farmers showed positive relationship with adoption of UASB technology, indicating, with increased education level they are more likely to appreciate new ideas and adopt them quickly. It could be also observed from the results of the econometric model that a unit increase in the education level of farmers would increase the adoption of VCF-0517 sugarcane by 31.20 percent. However, even though land holding and farm income showed positive relation with adoption of UASB sugarcane variety but were found not significant, whilst family size had a negative relation with adoption of UASB technology but found not significant. These results are in line with the study conducted by Gerald *et al*., 2021, where the results of all chi-square (X2) statistics were highly significant ($p < 0.000$) indicating that the models had strong explanatory power. The number of years of formal education, group membership, availability of free seed, grain market accessibility and seed accessibility positively influenced farmers to adopt seeds of improved sorghum. This implies that for every unit increase in any of these variables, the adoption probability increases by the magnitude of their marginal effects, *i.e.*, 19.9%, 1%, 26.5%, 21.2% and 46.1% for years of formal education, group membership, free seeds, grain market accessibility and seed accessibility, respectively. These results are on par with the study conducted by Thedy et. al., (2021) [4] where the probit estimates revealed that age, sex, years in school, group membership, farm size, grain market and grain prices significantly influenced farmer adoption of improved sorghum technologies.

Access to credit showed positive and statistically significant influence in adoption of UASB sugarcane technology. This signifies that better access to farm credit enabled farmers to afford the capital-intensive nature of new technology. The marginal effect for this input indicated that an increase in access to credit would increase the adoption of UASB technology by 13.40 percent. in other words, better access to credit by farmers would favor adoption of UASB technologies among farmers. The extension service showed positive and significant relation with adoption of UASB sugarcane variety. The marginal effect value (0.218) indicated that with the increased number of contacts with extension services by farmers, the adoption of UASB sugarcane varieties would increase by 21.80 percent. The study conducted by Udima *et al*., (2017) [5] are in line with results this study, where it was observed that, the farmers who have access to credit are more likely to accept the (Nerica) rice technology) in Ghana. The extension source was positive and significant in influencing the adoption of the technology. It is acknowledged that farmers are likely to be influenced to make adoption decisions by information sources which they consider most important since such sources are associated with reliability and credibility (Rogers, 2003) [6].

Summary and conclusion

In the evolving agricultural landscape, the dissemination of information about new innovations is crucial for advancing agriculture and improving farmers' livelihoods. However, the adoption of these innovations is influenced by a range of socio-economic, institutional factors and political factors. While these factors play a critical role, political factors are beyond the scope of this paper.

The results from the econometric model show that socio-economic factors, such as the age and education level of farmers, significantly influence the adoption of UASB technologies. This highlights the crucial role of socio-economic factors in promoting the widespread adoption of new innovations, which in turn can improve the living standards of farmers. Additionally, institutional factors like access to formal credit and extension services have positive and significant impact on the adoption of the VCF-0517 sugarcane variety. Based on these findings, policymakers are advised to focus on enhancing farmer education and making extension services more accessible in rural areas. Furthermore, streamlining the process for obtaining formal credit, particularly in rainfed regions where crop productivity is often two to five times lower than its potential (Wani *et al*., 2012) [7], is essential to boost agricultural production.

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