



LETTERS

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ASSESSING THE FACTORS INFLUENCING ADOPTION OF WEATHER BASED CROP & LOCATION SPECIFIC ADVISORIES SERVICE

1. The real-time availability of weather information plays a crucial role in agricultural production, food security and sustainable production (Haile 2005, Rathore 2013, Pandey and Singh 2019). Thus, any slight aberration in obtaining key weather parameters by farming community can significantly disrupt supply chain besides jeopardising lives and livelihood of millions of farmers. It is well established that weather parameters influence agricultural operations farm production and productivity, while weather aberrations is one of the important reasons for crop loss in India (Chattopadyaya *et al.*, 2011, Rao *et al.*, 2015, Das *et al.*, 2018). Most farmers' lack real-time weather-related recourses make specific decisions on cropping. Further, the weather-related data for a particular crop is seldom available on a single platform (Kumar *et al.*, 2015) though the ICT rooted strongly. The lack of availability of real-time weather-related resources and seasonal droughts and extreme weather events significantly narrowed farm output and income since the beginning of the 21st century (Rao *et al.*, 2015) and it is further expected to increase the yield variability across major crops (Singh *et al.*, 2020). This information gap forces many farmers to leverage their past experience and traditional/ indigenous knowledge as a means to making farm and crop specific decisions. In fact, the accuracy of prediction of the weather events in this method is abysmally low resulting in increased vulnerability to weather aberrations while raising concerns on production and productivity in feeding the growing population. Further, more it is pertinent to note that the lack of availability of real time weather-related information and seasonal droughts and extreme weather events significantly narrowed the farm output and income since the beginning of the 21st century (Rao *et al.*, 2015). As weather factors are key to in decision-making (Gadgil *et al.*, 2002) of crop selection, response strategy and agricultural productivity (Frisvold, and Murugesan 2013). In rainfed areas it is highly desirable to know accurate weather forecast to minimize loss and harness farm production. Hence information pertaining to weather

events plays a vital role in resilient agricultural production, farmer's income and savings (Carlson 1989, Maini and Rathod, 2011) besides investment. In India, providing weather related information has improved considerably in the last three decades since the Information Technology revolution in the 90s. The accuracy of prediction of weather parameters with a reliable mode land institutional set up has also reached nooks and corners of country, especially in rural and semi-urban, areas. Thus, farming is now integrated with information technology to avoid losses stemming from weather aberration. *Gramin Krishi Mausam Seva* (GKMS) of Rajasthan is one such institution that was established to serve weather related information to farmers and support them to adapt to influence decision-making. The study focuses to (i) Enumerate general factors influencing the adoption of GKMS information, (ii) Identify any additional factors that helps in changing conventional adoption behaviour (iii) To know the extent of adoption of information with the factors recognised (marginal effects).

1.1. *Adoption of Information* - Although a country has a reliable set of functionaries engaged in providing weather related information to farmers, success lies in the number of farmers who actually adopt in decision-making and insulate themselves from weather aberrations (Mittal and Mehar 2016). The farmers who adopt such information and advisory services stands to net benefit side by increasing yield and reducing cost (Maini and Rathod, 2011). In addition, studies worldwide established that there is a significant link between the weather parameters, climate change events and yield variability (Ray *et al.*, 2015) of major crops and farmers income. Thus, it does not permit one to disregard the influence of weather parameters on agricultural production (Guiteras, 2009) after taking stock of influential factors. Some key factors that influence information adoption include household characteristics (Age, education, experience, among others) (Mehar and Mittal 2016, Ali 2010), plot characteristics (Size, fertility status and others), market access and major climate risks (Aryal *et al.*, 2018).

Further, as noted in the beginning, weather information advisory services in India are quite well organised and its information dissemination is relatively robust. However, the adoption of such information in decision-making and crop choice has not reached a commendable level (Anuga, S. W. and Gordon, C 2016).

Thus, assessing the underlying factors for non-adoption of the same agro-advisories assume considerable importance. On the one hand, identification of factors help us with effective planning and management of agricultural practices, like choice of cultivar, sowing and need-based application of fertilizer, pesticides, efficient irrigation and harvest, weather forecasts altogether temporal ranges are desirable. On the other hand adoption of daily weather forecast and medium ranges aid in short-term adjustments in daily agricultural operations which minimize losses resulting from adverse weather conditions and improve yield levels and grain quality.

1.2. *Gramin Krishi Mausam Seva (GKMS)* - In India, weather advisory services for the farming community started in 1988 with evolving mechanisms, projects and institutional support. It was felt in the beginning of the 12th Five Year Plan (FYP) that the preparation of the weather forecast for a region smaller than district is necessary while extending the temporal range of the weather forecast and also extensive outreach of agro-met advisory services. Thus, the shaped formation of GKMS project as a part of the 12th FYP under the ministry of Earth Science in the country. The main objective of the project is to improvise the existing District level Agromet Advisory Services (AAS) and to deliver crop and location specific AAS to farmers at block level with village level outreach. Later, Agro-met Division of India Meteorological Department (IMD) through *Gramin Krishi Mausam Seva* (GKMS) program, generated weather forecasts and Agro-met advisories, which are disseminated via SMSs through the portal “mKisan” for registered users. Also, Under the Public Private Partnership (PPP) mode, IMD together with private service weather service provides like Reuter Market light, IFFCO *Kisan* (IK), NOKIA-HCL, Handygo, *Mahindra Samridhi*, and CAB International have started offering location-specific Agro-met information in order to increase information outreach. The major channels, like SMSs, voice messages, and app-based portals were leveraged to reach out to the farm communities.

2. *Research methodology and study area* - The Empirical approach of the Probit model was adopted to assess the sample farmer’s adoption decision and underlying factor influencing the use of *Gramin Krishi Mausam Seva* (GKMS) and the descriptive statistics for demographic and economic variables.

Bikaner district of Rajasthan state was selected for the present study as the region is often exposed to major climate and extreme weather events. The region is semi-arid witness large scale weather-related agricultural risk as noted by earlier studies (Singh *et al.*, 2019). Another region is found to have the highest number of adopters of

TABLE 1

Demographic and economic characteristics of the surveyed farmers

Variable	Frequency	Percentages
Education		
Illiterate	36	30.00
Primary	22	18.34
Secondary	28	23.33
Senior secondary	19	15.83
Graduate	15	12.50
Age		
<30	15	12.50
30-55	79	65.84
>55	26	21.66
Family type		
Joint	84	70.00
Nuclear	36	30.00
Farm size		
Marginal & small (0-2 hectare)	2	1.66
Medium (>2-4 hectare)	14	11.67
Large (>4 hectare)	104	86.67
Annual income (farming + non farming)		
<4 lakh	26	21.66
4-7 lakh	67	55.84
>7 lakh	27	22.50
Farming experience		
Less than 10 year	23	19.16
10-34 year	76	63.34
>34 year	21	17.50

Source : Field Survey, 2019

*Categories of age, income and farming experience were classified based on SD \pm Mean

the GKMS scheme. Further, multi-stage random sampling was employed for selecting respondents. Four villages were randomly selected among the list of adopter villages registered under the GKMS. 60 beneficiary farmers were randomly selected from these villages. While the 60 respondents were randomly selected from the non-adopter villages located at a distance of 100 km from beneficiary villages, to avoid any significant biasness in assessment. Thus, sampling the framework consists of 120 farmer-respondents from eight villages (60 beneficiary and 60 non-beneficiary farmers) with similar cropping pattern and geography. While the adopter farmers were considered if a farmer who adopted any one practices/price of information recommended by GKMS.

TABLE 2
Explanatory variables of the probit model

Variable	Unit of Measurement	Description	Expected Sign
X ₁ Age	In years (continuous)	Younger farmers are more likely to adopt than older farmers	+
X ₂ Education level (Dummy)	Dummy (1 = informal education, 2 = primary education, 3 = secondary education, 4 = above secondary education)	Formal educated farmers are more likely to adopt than those with informal education levels	+
X ₃ Technology used during crop production	Dummy (0 = local technology, 1 = advanced technology)	Farmers who use modern equipment in crop production are more likely to adopt <i>Gramin Krishi Mausam Seva</i> (GKMS) compared to others	+
X ₄ Farming experience	In years (continuous)	The high the experience, more likely to adopt <i>Gramin Krishi Mausam Seva</i> (GKMS)	+
X ₅ Farm size	In hectare (continuous)	Large farm owners are more likely to adopt the use of <i>Gramin Krishi Mausam Seva</i> (GKMS) compared to small farm size owners	-
X ₆ Household size	Household member (continuous)	Large household farmers are likely to adopt better than small household size	+
X ₇ Income	In currency (continuous)	High income earners are likely to adopt more compared to low income earners	+
X ₈ Family type	Dummy (0 = nuclear, 1 = joint)	Joint family farmer is likely to adopt more compared to nuclear family farmer	+

Source : Field Survey, 2019

2.1. *Empirical Probit model* - The Probit adoption model is used to understanding adoption behaviour of farmers and to identify factors influencing the use of *Gramin Krishi Mausam Seva* (GKMS) in communicating agriculture information. Indeed, the Probit model is a suitable econometric model for the binary dependent variable (Table 2) and the error term is assumed to be normally distributed (Gujarati, 2004).

The Probit model specification in this analysis can be written as:

$$Y = F(X' \beta) + \varepsilon_i$$

$$Y_i = \begin{cases} 1 & \text{if adoption} \\ 0 & \text{if no adoption} \end{cases}$$

where; $\varepsilon \sim N(0, 1)$

β = Maximum like hood

i = Cumulative distribution functions of standard normal distribution

ε = Error term

x = Set of an independent variables

Independent variables were age, education level, household size, farm size, farming experience and income. The model estimates coefficient that gives direction of the effect of the independent variable on the dependent variables, so we obtain the actual magnitude of the change of probabilities through marginal effect.

2.2. *Marginal effect* : Marginal effect used to reflect the change in probability of independent variable in a given change of dependent variable.

$$\text{Marginal effect} = \frac{\partial Y_i}{\partial X_i}$$

where:

Y_i = dependent variable, that is use of *Gramin Krishi Mausam Seva* (GKMS)

X_i = independent variables

TABLE 3
Factors influencing adoption of GKMS in communicating agriculture information

Probit model variables	Robust			Marginal effect		
	Estimates	Std.Err	P> z	dy/dx	Std.Err	P> z
Age	0.071**	0.0961	0.941	0.132	0.009	0.686
Education	0.284*	0.6507	0.015**	0.318	0.040	0.082***
Farm size	0.064**	0.0218	0.003**	0.207	0.003	0.117
Household Size	0.024	0.1470	0.869	0.011	0.025	0.933
Farming Experience	0.001***	0.0832	0.994	0.168	0.009	0.622
Family type	0.241	0.6279	0.702	0.111	0.087	0.414
Income	-0.120*	0.1509	0.427	-0.137	0.018	0.310
Use of technology	0.596	0.6490	0.359	0.103	0.101	0.435
Restricted Log-L	-178.224					
Mc-Fadden Pseudo-R ²	0.74852					

Source : Field Survey, 2019

***Significant at 1% Probability Level **Significant at 5% Probability Level * Significant at 10% Probability Level

δ = show change in probability of independent variable in a given change of dependent variable.

3. Results and discussion

3.1. Descriptive statistics of the surveyed farmers

Table 1 indicates the demographic and economic profile of the study area. On education level it denotes that more than one third of farmer-respondents were illiterate and more than three a fourth of the respondents were in the age group of 30-55 years. Joint family system prevails with large farm size with two thirds of them having income of 5-7 lakh and 10-34 years of farming experience.

3.2. Results of the Probit Model

The coefficient, estimations presented in Table 3 gives direction of the effect of the independent variable on the dependent variables to obtain the actual magnitude of the change of probabilities through marginal effect.

The Probit analysis suggests that the variables on farm size is significant but has a negative impact on the adoption of GKMS, as farm size increase, the probability

of adopting GKMS decreases because medium category of farmers is more likely to adopt GKMS compared to large category farmers. Well educated farmers are more likely to adopt GKMS compared to less educated farmers and it is consistent with studies reviewed earlier by Mittal and Mehar (2016) which found that education creates conditions that enable farmers to acquire and use knowledge for decision-making effectively. While the increase in farmer’s education led to increase in probability of adoption of GKMS. This shows that education has positive significant to the adoption of GKMS. Indeed, educated farmers have the ability to understand importance of using GKMS compared to other farmers. Similar findings were obtained in a study by Mittal and Kumar (2000) who examined that education helps farmers to better understanding of modern information and also to acquire and use knowledge for effective decision-making. It also allows the farmer-adopter to increase the allocative and technical efficiency by adopting the information of GKMS.

Table 3 shows that extension services are significant. It is acknowledged that farmers are likely to be influenced to make adoption decisions by information sources which they consider them most important since such sources are associated with reliability and credibility (Rogers, 2003).

The results show that education plays an important role in adoption of information. This indicates that educated farmers use more information about local weather conditions to increase their production levels. Thus, the model estimates an increase in education by one unit will result in an increase 28 percent increase in the probability of adoption of information. The coefficient for education level has the expected positive sign and is statistically significant at 10% level for adoption.

Farming experience has also been found to significant. It shows, for an old aged farmer have more farming experience and has a high propensity for adoption in comparison to younger or median old farmer. The coefficient for farming experience is statistically significant at the 1% level in the Probit model.

Income is hypothesized to compensate for any additional financial resources that are associated with new technologies. The coefficient for income has a negative effect on the adoption of information. The parameter is statistically significant at 10% level of the Probit model. For the intensity of use, the coefficient is negative. Results are contrary to what is reported by Chirwa (2005) and are also supported by the findings of Makokha *et al.*, (2001). This negative effect could be attributed to the higher relative returns from other investments. If farm enterprises have higher returns, then smallholder’s farmers might

prefer to invest in enterprises that have better returns, given the weather-related risk involved in agriculture.

In this study, farm size in hectares is taken as a proxy for wealth. The coefficient for farm size is positive, as hypothesised (Table 3). The coefficient is statistically significant at 5% level for the Probit model. A unit increase in farm size increases the probability of adoption of information. This finding is consistent with other studies carried out on adoption of agricultural technologies (Zegeye *et al.*, 2001, Knepper, 2002, Chirwa, 2005). The findings support the notion that farm size influences information adoption, which is compatible to access to agricultural inputs and other services. Further, by employing maximum likelihood ratio of the estimated coefficients and standard errors revealed the major factors influence adoption of GKMS in communicating agriculture information. A statistically significant coefficient suggests that the likelihood of decision-making using GKMS by farmers will increase/decrease is based on the response of the explanatory variable (increases/decreases). The likelihood ratio test statistics results of the model indicate that all variables are statistically significant. McFadden's Pseudo- R^2 was calculated, and the values thus obtained indicate that the independent variables included in the Probit model explain a significant proportion of the variations in farmer's decision in using GKMS. Estimate of 0.74 indicates that variables specified in the model for estimation explain high-level of the probability to using GKMS.

4. Conclusion

In the dynamic and changing agricultural scenario, agricultural information plays a decisive role for the overall development of agriculture as well as improving the livelihoods of farmers. Agriculture information requirements are changing continuously owing to changing needs of agricultural activities and also increasing awareness amongst farmers besides ICT use. The GKMS helps farmers by providing weather-related key information and this serves as key element in improving their decision-making. The adoption of weather-related Information provided by GKMS acts as an instrument in overall agriculture development as it insulates farm production from weather related aberration. Thereby the vulnerability of farmers and variability in yield levels of the region can be reduced significantly.

The factors that may influence farmer's adoption of different information sources include education level, age, farming experience, income and farm size. Besides they also play important role while accessing agricultural information from GKMS. The probability of the adoption

of GKMS to access agricultural information increases with increase the educational level, age, farming experience, income and farm size. Income is significant but has negative effect on the adoption of GKMS, as income increase, the probability of adoption of GKMS decreases. The results held to reject the null hypothesis which stated "Factors like age, education level, farm size, family type, household size, farming experience, use of technology during production and income have no influence on the adoption of GKMS".

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