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A Logit Analysis of Farmers' Knowledge Regarding Zero Tillage in Wheat

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ABSTRACT

Zero tillage (ZT) technology in wheat has demonstrated considerable agronomic and economic benefits by reducing energy costs and improving soil and water quality. The study attempted to find the knowledge level of farmers regarding zero till wheat and factors associated with it. The study was conducted in the south-western district named Sri Muktsar Sahib of Punjab. A total of 150 farmers were selected from the district through multistage sampling. A knowledge test was prepared and pre-tested on 20 non-sampled farmers. Study revealed that majority (76%) of farmers had medium level of knowledge about ZT wheat. Farmers lacked knowledge regarding some important aspects such as application of pre-sowing herbicide and depth of seed. Membership of co-operative society, mass media exposure, extension contacts and participation in extension activities were found to be significantly correlated ($p \leq .01$) with knowledge level of farmers. Logit analysis revealed significant influence of mass media ($p \leq .01$) and extension contacts ($p \leq .05$) on the knowledge level.

Keywords: Zero Tillage in Wheat, Knowledge, Logit analysis

INTRODUCTION

Knowledge is the foremost component in the innovation-decision process. Knowledge occurs when an individual is exposed to the innovation's existence and gains some understanding of how it functions. At knowledge stage of innovation-decision process, individual wants to know, what the innovation is and how and why it works (Rogers, 2003). Further, the innovation decision process leads to either adoption or rejection of an innovation. Researchers have started to pay much attention towards knowledge components to understand the uptake of innovation (Meijera *et al.,* 2014). Degradation of natural resources is a major problem faced all over the world in the present era. Conventional or modern agriculture has largely been characterized by tillage which includes, soil loosening and leveling for seed bed preparation, mixing fertilizer into soil, weed control and crop residue management (Hobbs *et al.,* 2008). However, continuous use of conventional farming practices with conventional tillage (CT) has degraded the soil resource base (Montgomery, 2007). The current scenario of rising fuel, fertilizer and other input cost, necessitates the effective use of resources in agriculture. So, there is need of resource efficient systems that can sustain soil, water and environment quality and produce more at less cost (Jat *et al.,* 2011). The CA technologies involving no- or minimum tillage with direct seeding and bed planting, residue management (mainly residue retention) and crop diversification (Gupta and Sayre, 2007) have potential for improving productivity and soil quality, mainly by soil organic matter (SOM) build-up (Bhattacharyya *et al.,* 2013).

Among the CA technologies, researcher-managed field trials across South Asia, zero tillage has demonstrated considerable agronomic and economic benefits, while improving the environmental footprint of agriculture by reducing energy costs and improving soil and water quality (Chauhan *et al.,* 2012; Gathala *et al.,* 2013). In ZT wheat, agronomic factors leading to productivity advantages are related to time savings in crop establishment, allowing earlier sowing and, hence, reducing risks of terminal heat stress during the grain-filling phase. There is better control of weeds, such as Phalaris minor, better nutrient management; and water savings (Gathala *et al.,* 2013) reported in ZT wheat. ZT wheat is the most widely adopted resource conserving

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technology in the rice-wheat systems to date, especially in the Northwestern Indian IGP (Derpsch *et al.,* 2010). Hence, knowledge is an important component in the innovation-decision process. So, present study was planned to find the knowledge level of farmers regarding zero tillage in wheat and factors influencing the knowledge level.

METHODOLOGY

The study was carried out in South-western part of Punjab. The multistage sampling procedure was used for selection of respondents. Sri Muktsar Sahib district of South-western part of Punjab was purposively selected from south-western part of the Punjab. Further two blocks and four villages from each block were selected randomly. Thus a total of 150 farmers from eight selected villages were chosen based on the probability proportion to the number of farmers in each village. A semi-structured interview schedule comprising knowledge test regarding zero tillage in wheat was developed and pre-tested on 20 non-sampled farmers. Validity of knowledge test was found through jury opinion and intrinsic validity calculation. A difficulty and discrimination index for knowledge test was calculated and statements were rephrased accordingly. Empirical values of reliability and validity were found to be 0.83 and 0.91 respectively, are acceptable for social science research.

The study was conducted in the year 2015-16 and data were collected by means of personal interview to get information regarding knowledge of farmers about zero tillage in wheat. Data collected were subjected to descriptive statistics, included frequencies, means and standard deviation. Farmers were categorized in Low, medium and high category of knowledge level by use of mean and standard deviation. Relational and predictive analysis tools were to determine the factors influencing the knowledge of farmers.

Many researchers used linear regression methods to found determinants of knowledge, which requires the assumptions about distribution of independent variable, normal distribution, linearly related and equal variance. But, these assumptions were difficult to fulfill in the present survey research. So, Logistic regression was used for this study, which makes no assumption about above mentioned. Logistic regression is extremely used in social research when the dependent variable is dichotomous. The independent or predictor variables in logistic regression can take any form. The dependent variable takes the value 1 with a probability of success, or the value 0 with probability of failure. Knowledge level of farmers was dichotomized by considering mean knowledge level as cut-point. A value of 1 was given to those, who had the knowledge above mean knowledge level and value 0 was given to those, who had knowledge below mean knowledge level. The logistic equation is written as (Greene, 1993).

$$\mathbf{P}_i = \frac{e^{\beta x}}{1 + e^{\beta x}}$$

Where P_i = 1(for knowledge above mean knowledge level and 0 for knowledge below mean knowledge level). Since logistic regression calculates the probability of success (p) over the probability of failure (q), the results of the analysis are in the form of an odds ratio (p/q).

$$odds = \frac{P}{1 - P}$$

Logistic transformation being nonlinear in nature uses the maximum likelihood estimate (MLE) method to find the most likely estimates for the coefficients. Instead of minimizing the squared deviations (least squares) MLE maximizes the likelihood that an event will occur. The best fit logit model is based upon the statistics namely likelihood ratio, denoted as -2 log likelihood (-2LL). The minimum value of -2 log likelihood is 0, which corresponds to a perfect fit, hence; the lower its value, the better the model.

Chi-square test of significance and Nagelkerke R2 value provide the basis to represent the overall model fit. Wald statistics provides the statistical significance for each estimated coefficient (β) (Padaria *et al.,* 2009). In this study the estimated coefficients represent the influence of age, family type, education, land holding, mass media exposure, extension contacts, social participation, and membership of cooperative society on farmer knowledge of zero tillage in wheat.

RESULTS AND DISCUSSION

A priori expectation in the study was that following eight independent variables will affect the knowledge of farmer regarding zero tillage in wheat. The variables were explained in Table 1. Further, descriptive analysis of variables presented in Table 2 revealed that mean age of farmers was about 43 years and majority had nuclear families. Mean education and operational land holding was found to be 2.67 and 21.80 acres, respectively.

Table 1: Description of model variables

Variable		Measurement
Dependent		
KNOW	Knowledge level of farmer regarding zero tillage in wheat	Score obtained from knowledge test comprised 9 statements. **Dichotomized Categories (mean score = 5.40)** 1= knowledge level above mean score 0= knowledge level below mean score
Independent		
AGE	Age of the respondent	In years
FAMTYP	Family Type	Nuclear =1; Joint = 2
EDU	Education of the respondent	Illiterate = 0; Primary = 1; Middle = 2; Matriculation = 3; Senior Secondary = 4; Graduate = 5; Post Graduate = 6
OPLAND	Operational land holding	In acres
COSM	Membership of co-operative society	Non-member = 0; Member = 1; Office Bearer = 2
MASMED	Frequency of using different media viz radio, television, farm literature and newspaper	Always = 3; Sometimes = 2; Never = 1
EXTCONT	Frequency of contact made by the respondents with different extension agencies	Always = 3; Sometimes = 2; Never = 1
PARTEXT	Frequency of participation in different extension activities viz. field days, demonstrations, campaigns and *Kisan Melas*	Always = 3; Sometimes = 2; Never = 1

Table 2: Descriptive Statistics of variables used in model

Variables	Min.	Max.	Mean	Std. Dev.
AGE	25	62	43.08	9.787
FAMTYP	1	2	1.43	0.496
EDU	0	6	2.67	1.417
OPLAND	2	70	21.80	15.380
COSM	1	2	1.05	0.225
MASMED	12	22	15.20	2.380
EXTCONT	5	13	6.68	1.922
PARTEXT	6	14	8.06	1.723

Knowledge Level of Farmers

Different categories of farmers were formed using the mean knowledge level and its standard deviation and data were presented in Table 3. It indicated that majority (76%) of the farmers had medium level of knowledge about zero tillage in wheat.

Table 3: Distribution of farmers according to their knowledge level

Category	Score	Frequency	Percentage
Low	<3.75	22	14.67
Medium	3.75-7.05	114	76.00
High	>7.05	14	9.33

*Mean Score = 5.40; SD = 1.65

Further, it was necessary to find out the different aspects of zero tillage in which farmers lacked knowledge. So, close examination of data (Fig 1) revealed that only six per cent of farmers had knowledge about the application of pre-sowing herbicide in zero till wheat. Other pitfalls in knowledge of farmers were accurate depth of seed and effect on leguminous crop on quantity of nitrogenous fertilizer. About half of the farmers had not knowledge about recommended doze of nitrogenous fertilizer and applied more quantity than recommended. These gaps in knowledge can lead to low germination of wheat and high crop-weed competition.

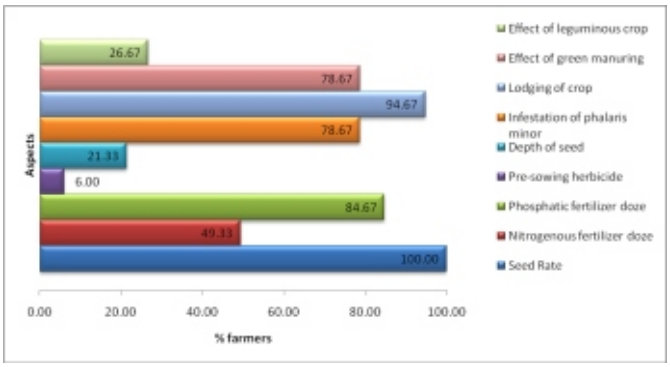

Fig 1: Knowledge level regarding different aspects of zero tillage in wheat

Determination of factors influencing the knowledge of farmers

The correlation analysis is one of the most common and most useful statistics in social research which indicates the extent to which two variables move together. Results presented in Table 4 revealed that membership of co-operative society, mass media exposure, extension contacts and participation in extension activities were positively correlated with knowledge about zero tillage in wheat.

Table 4: Correlation between Socio-personal characteristics of respondents and their knowledge level

Dependent Variable	Knowledge Level
Independent variable	**Pearson Correlation Coefficient**
AGE	-.016^{NS}
FAMTYP	-.095 ^{NS}
EDU	.086 ^{NS}
OPLAND	.123 ^{NS}
COSM	.484**
MASMED	.332**
EXTCONT	.230**
PARTEX T	.248**

*Significant at 5%; ** Significant at 1%

But correlation coefficient only determines linear relationship between two variables irrespective of variable type (dependent/independent). It does not predict the influence of independent variables on dependent variable. So results of logistic analysis were presented in Table 5. The Hosmer-Lemeshow significance value was 0.507, which shows a good model fit. The Hosmer-Lemeshow statistic indicates a poor fit if the significance

value is less than 0.05. Nagelkerke R^2 and -2 Log likelihood values were found .286 and 171.516 respectively, which confirms a respectable model fit. Regression results provide the values of coefficients (B), their standard errors, the Wald statistic, significance and odd ratio (Exp (B). The Wald statistic and associated probabilities provide an index of the significance of each predictor in the equation. The Exp (B) column in the table presents the extent to which raising the corresponding measure by one unit influences the odds ratio. Exp (B) can interpreted in terms of the change in odds. If the value exceeds 1 then the odds of an outcome occurring increase; if the figure is less than 1, any increase in the predictor leads to a drop in the odds of the outcome occurring. The 'B' values are the logistic coefficients that can be used to create a predictive equation.

Table 5: Results for logistic regression model for knowledge level of farmers

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	-6.890	1.896	13.202	1	.000	.001
AGE	-.033	.021	2.435	1	.119	.968
FAMTYP	.357	.383	.868	1	.351	1.429
EDU	-.041	.145	.080	1	.777	.960
OPLAND	.000	.013	.001	1	.976	1.000
COSOC	1.130	1.155	.957	1	.328	3.095
MASMED	.387	.109	12.725	1	.000**	1.473
EXTCONT	.234	.119	3.839	1	.050*	1.263
PARTEXT	-.056	.130	.189	1	.664	.945

-2 Log likelihood = 171.516Nagelkerke R^2 = .286
Hosmer and Lemeshow Test Significance = .507
Level of significance: ** ($P \leq 0.01$); * ($P \leq 0.05$)

In contrary to our hypothesis, age, family type, education level, operational land holding, co-operative society membership and participation in extension activities had not any significant influence on the knowledge level of farmers. But mass media and extension contact had significant results at one per cent and five per cent level of significance, respectively. The corresponding odds ratio (Exp (B)) for both mass media and extension contacts were 1.473 and 1.263 respectively. Thus we can say that when the mass media exposure increases by one unit, the odds of increasing knowledge level of farmers increases by a factor of about 1.5 times. Generally used mass media sources by farmers were TV, newspaper and farm literature, which provided reliable information to the farmers. Similarly, if extension contact increases by one unit, the odds of increasing knowledge level of farmers increases by a factor of about 1.25 times. As a result, flow of information and guidance increased through various increasing contacts of farmers with SAU/KVK scientists, personnel of state agriculture departments or other credible sources. The estimated model for predicting the knowledge of farmers about zero tillage in wheat can be written as following:

$$P(Y=1) = \frac{e^{1.473 \times MASMED + 1.263 \times EXTCONT - 6.890}}{1 + e^{1.473 \times MASMED + 1.263 \times EXTCONT - 6.890}}$$

CONCLUSION

Farmers' knowledge about a specific technology play an influential role in continuing adoption of any technology. Results of logit regression revealed that mass media and extension contacts had significantly influenced the knowledge of farmers. Hence the different mass media sources like television, farm literature, newspaper and other ICT tools can be used to further enhance the knowledge level of farmers about different agricultural technologies. Modern mass media tools viz. social media can also be used to avail the information to the farmers, whereas physical contact by extension personnel can reinforced the information.

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