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Understanding the farmers' behaviour towards water saving irrigation technologies

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Introduction

The increase in population has placed a heavy burden on grain production on limited arable land in China. The water resources in China are unevenly distributed both in time and space (Li et al., 2005). There are more abundant water resources in the South than in the North. The North China plain alone produces roughly one quarter of China's grain (Zhang et al., 1998). The region has intensive double cropping system i.e. winter wheat and summer maize. About 50 to 75 % of the total precipitation occurs from July to September, during the maize growing season and only 25-40% at the time of winter wheat (Li et al., 2005). As a result, agriculture is the main reason for groundwater depression and has dramatically decreased from 10 meters in 1975 to 35meters in 2000(Changming et al., 2001; Zhang et al., 1998).

There has been extensive research which has focused on the adoption of advance or water saving technologies by farmers. Skaggs, (2001) examined the adoption of drip irrigation and concluded that age (negative impact) and farm size (positive impact) are the major factors influencing Mexican chile pepper producers' decisions. Further, Larson et al., (2008) evaluated the factors that influence the adoption of remote sensing for variable-rate application of inputs. They found out that age, education, farm size, contact with extension service centre and the farmers who generate their own maps in the field are the factors which govern their decision to use the technology. Blanke et al., (2007) conducted a survey in northern China to determine the extent to which water saving technology has been adopted, and the characteristics of the communities that have been adopting them. They found that the main reason for not adopting the new technologies is due to lack of incentives to save water. And though the adoption has increased since the water resource condition deteriorated, but the extent of adoption was still quite low and there is a

considerable room for expansion. There is a lack of sufficient understanding of reasons affecting farmers' adoption behaviour. Therefore, the objective of this research is to fill this research gap and to develop a better understanding and predict farmers' adoption behaviour. The specific objective is to determine the socio-economic factors which influence farmers' adoption decision in Hebei province, NCP.

Material and Methods

The study area is located in the Hebei province in the north part of the NCP. Its geographical location is between 36°05′ to 42°40′ N latitudes and 113°27′ to 119°50′ E longitudes. Two counties namely, Wuqaio and Quzhou were selected to conduct this study. A household survey was conducted on 210 randomly selected farmers from 10-13 villages of each county. Both qualitative and quantitative data was collected using an unstructured questionnaire with both open and closed questions. The explanatory variables and their hypothesis are shown in table 1.

Table 1. Explanation of variables in the empirical binary logistic model

Acronym	Description	Expected Sign
Dependent variable		
WILL	Dummy (1 = want to change,0 = not change)	-
Explanatory variables		
	Farmers' Characteristics	
AGE	Household head's age	-
EXP	Number of years working in the field	-
EDU	Household head's education level	+
CONT	Contact with extension service centre or village committee	+
FSIZ	Family members in one household	-
LABE	Number of family members available to work in the field	-
HEDU	Highest education level in the household	+
	Farm Characteristics	
CROP	Type of irrigated crops	+
PROB	Present irrigation have problems or not	+
TRY	Interest to test water saving technologies	+
AREA	Land area	-
	Economic Characteristics	
AINCO	Agricultural Income	+
LOAN	Farmer's have outstanding loans or not	-
NAINCO	Non agriculture income	-
SUB	If subsidy available for new irrigation system	+
ATTINCO	Farmer's attitude towards Income	+
RATE	Water rate / area / irrigation time	+
COST	Cost per land area (include seeds, fertilizers, water, etc)	-
	Agro-ecological Aspects	
ATTI	Water is an important parameter to increase yield	-
WSH	Would like to attend workshop or not	-
FWSHO	Future prediction about water situation	+
SAVE	Try to save irrigation water or not	+
WSHO	Farmer's attitude toward water shortage	+
ATTM	Attitude towards water saving technologies	+
OPT	Optimistic about future crop yield or not	+

The decision to adopt is a YES/NO type of variable, estimation of the effect of various variables was done using binary logistic regression model. In this study, the predicted logit probabilities of adoption or not adoption can be explained by the following equation:

P_i = Pro(Y, 1 yes, and 0, no) (1)

$Zi = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_i X_{ki}$ (2)

Z_i is an indirect utility derived from the dichotomous decision. And X_1, X_2, ...,X_{ki} are the independent variables which include a set of parameters like farmer's characteristics, socioeconomic factors and farmer's attitudes which might influence their decisions. β_0 is the intercept term. And $\beta_1, \beta_{2,\ldots..}, \beta_i$ are estimated coefficient parameters.

$$\ln\left(\frac{P_i}{1-P_i}\right) = \text{lnodds} = Z_i \quad (3)$$

Where, P_i stands for the predicted probability that the i^{th} farmer has a problem with their present irrigation method, which is coded with 1, while (1-P_i) presents the predicted probability that the i^{th} farmer does not think there is a problem with their present irrigation method, and coded with 0. The result is displayed by using the odds ratio which can be easily converted back to probabilities according to the following formula. $\hat{Y}$, is the predicted probability of the event which is coded with 1 rather than with 0.

$$\hat{Y} = \frac{Odds}{1+odds}$$

Results and Discussion

The estimated logit model results are given in table 2 and the regression equation is as follows:

ln (Pi/1-Pi)= – 1.829 + 0.51×**RATE** + 0.153×**FWSHO** + 0.316× **LABE** + 1.067× **PROB** – 1.427 × **LOAN**– 0.174× **FSIZ** – 0.032 ×**AGE** + 0.245 ×**ATTM**

The households which have more workforces (LABE) in the field show a high potential to change which is contradicting our hypothesis. This is because they want to earn more money from non-agricultural activities and therefore, want to make their field less labour intensive. On the other hand to have a secure future they also do not want to abandon their land. The household head's age (AGE) is negatively correlated with farmer's willingness to change at 5% significant level. Similar results was also found by Adesina and Chianu, (2002), where they concluded that household head's age influence negatively and the young farmers have a high potential to adopt new technologies. Further, loans (LOAN) is negatively correlated to change at the 10%

significant level. This implies that farmers who are already in debt do not want to invest in buying the new irrigation system. This could also means that they do not want to borrow money and hence are less risk takers.

Table 2**.** Variables influencing farmer's willingness to change in Hebei Province of NCP

	B	S.E.	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
					Lower	Upper
AGE**	-0.032	0.016	0.041	0.968	0.938	0.999
FSIZ*	-0.174	0.099	0.077	0.840	0.692	1.019
LABE*	0.316	0.182	0.082	1.372	0.961	1.959
FWSHO*	0.153	0.084	0.068	1.166	0.989	1.374
PROB***	1.067	0.376	0.005	2.906	1.391	6.069
ATTM***	0.245	0.048	0.000	1.277	1.163	1.402
RATE***	0.051	0.018	0.004	1.053	1.017	1.090
LOAN*	-1.427	0.825	0.084	0.240	0.048	1.210
Constant*	-1.829	1.071	0.088	0.161		

*Significance at 10%
**Sigificance at 5%
***Significance at 1%

Conclusions

It was found that farmers who want to adopt the water saving technologies like micro-irrigation(drip and sprinkler), travelling gun and mobile drip irrigation tend to be young, smaller family size, not in debt, paying more for irrigation, have positive attitude towards the technology, can foreseen the future water crises and are not satisfied with the present irrigation system.

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