ADAPTION OF CONSERVATION AGRICULTURE IN UZBEKISTAN

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ABSTRACT

Uzbek agriculture has some serious problems related to management of water and soil quality. The soil in many areas showed signs of severe degradation such as compaction, high degree of salinity, and low fertility, which causes to decrease the productivity of agricultural productions to 20-30 percent for the last decades. This is the main rationale for changing producing agricultural productions in a sustainable way by which adapting an innovative technology such as Conservation Agriculture. This paper analyzes the current adaption state/level of Conservation Agriculture practices of farmers through addressing with socio-economic, institutional and environmental factors that influence on the farmers' decision making, and reveals the prior factors that encourage or constraints the extension of CA in Uzbekistan. Logistic Regression and Probit models are applied to analyze those factors through ranking and categorizing the relative dependent variables. The model estimation is based on the survey conducted by mains of questionnaire, which includes farm household (age, education, knowledge level, awareness, attitude toward conservation practices, motivation) and biophysical characteristics crop land area, crop yield, soil moisture, bulk density, soil humus, and finally, farm financial characteristics; farm income, off farm activities, employment, and agricultural machinery). The investigation outcomes indicated that the variables such as size of farm or LAND and EMPLOYMENT RATE possess positive correlation and those were found one of the most sensitive factors for the adaption rate. While variables of SOIL_MOISTURE and SOIL HUMOUS are in the next rank to induce farmers to adapt sustainable technology, OFF FARM ACTIVITY, however, is prior factor that halts farmer's adaption. It was concluded that farmers' participation in extension-education courses, usage different level of information sources and communication channels are also strong trigger to the implementation and extension of innovative technology in Uzbekistan.

Key words: Conservation Agriculture, sustainable agriculture, Logistic Regression and Probit model, independent variables, environmental factors, adaption of innovative technology.

INTRODUCTION

Economy of Uzbekistan is heavily depends on agriculture, which accounted for 28 percent of GDP and employed 40 percent of labor force. Arable land only comprises 11 percent of the territory. Cotton and wheat are main crops in the country: wheat for domestic consumption and cotton for export. Cotton accounts for 40 percent of the gross value of agricultural production. The current agricultural condition of Uzbekistan requires an alternative innovative technology to conduct agricultural operations in a sustainable way such as Conservation Agriculture (CA) technology

Nowadays, however, productivity of agricultural productions reduced up to 20-30 percent for the last decades. Land degradation, water shortage, soil salinity, soil erosion, and low soil fertility are

becoming urgent problems in Uzbekistan. Evidently intensive irrigation and badly maintained drainage system are the primary cause of poor condition of the environment in many years. In former USSR period, the agriculture sector of Uzbekistan was largely focused upon the cotton cultivation and became net exporter of cotton. The negligent attitudes towards science based technologies, race for greater volumes of raw cotton and cotton monoculture, and extending new lands from Korakum and Kyzylkum desert areas, by drawing huge amount of water from Amudarya and Syrdarya rivers, have led to disastrous problems of agricultural lands in Uzbekistan, even were consequence for Aral Sea catastrophe in Central Asia.

The current agricultural condition of Uzbekistan requires an alternative innovative technology to conduct agricultural operations in a sustainable way such as Conservation Agriculture (CA) technology. CA is based on optimizing yields and profits, to achieve a balance of agricultural, economic and environmental benefits. It advocates that the combined social and economic benefits gained from combining production and protecting the environment, including reduced input and labor costs, are greater than those from production alone. CA, based on integrated practices such as zero/reduced tillage, crop rotations and permanent soil cover is becoming increasingly popular. Zero tillage, as a practice of CA, is now applied on more than 95 million ha worldwide, primarily in North and South America. Approximately 47% of the zero tillage technology is practiced in South America, 39% is practiced in the United States and Canada, 9% in Australia and about 3.9% in the rest of the world, including Europe, Africa and Asia.

Dramatic declining in crop yields due to above mentioned problems such as soil degradation and low soil fertility required radical change in both agricultural policy and practices in Uzbekistan. Recently, Uzbekistan researchers and scientists of agricultural institutions accompanied with international organizations (FAO, ICARDA, ZEF etc.) have launched different collaborative projects under the objective of sustainable agricultural development.

Main goal of the research is analyzing current adaption state/level of Conservation Agriculture practices of farmers through addressing with socio-economic, institutional and environmental factors that influence on the farmers' decision making, and to facilitate policy prescriptions and conceptual framework based on scientific calculation of adaptability of the alternative technology to decrease uncertainty and hesitation of risk aversion farmers. Conservation agriculture practice adaption is multidimensional process. Numerous factors determine farmers' willingness to use sustainable practice. So studies need to be conducted in search of factors influencing adaption of the new technology in Uzbekistan condition. Multiplicity of factors combined with the potential interactions between them contributes to adopting CA practices.

METHODS

For better understanding the factors affecting adaption of the sustainable technology, different type of models and statistic analysis are applied for comprehensive investigation. Logistic Regression and Probit models are employed to analyze the dependent variables or factors through ranking and categorizing method to identify the sensitivity of those variables to develop or the constraint the adaption process.

According to the model instructions, a questionnaire, which includes the data of individual level characteristics and farm structural factors characteristics, were collected through appraisal survey. Proportional random sampling method was employed to select the particular number of farms located different agricultural regions. Data were analyzed using descriptive and inferential statistics such as extent of mean, standard deviation, coefficient of variation, correlation analysis and stepwise regression analysis.

Logistic regression model estimation

In statistics, logistic regression (sometimes called the logistic model or logit model) is used for prediction of the probability of occurrence of an event by fitting data to a logit function logistic curve. Like many forms of regression analysis, it makes use of several predictor variables that may be either numerical or categorical.

$$\ln\left(\frac{P(Y)}{1 \cdot P(Y)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_K X_K \qquad P(Y) \qquad Probability of the event occurring \\ p(Y) = \frac{\exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_K X_K)}{1 + \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_K X_K)} \qquad \beta_1, \beta_2, \dots \beta_n \qquad \text{Line gradient or coefficients} \\ X_1, X_2, \dots X_K \qquad Predictor variable$$

Logistic regression is a variation of ordinary regression which is used when the dependent (response) variable is a dichotomous variable (i. e. it takes only two values, which usually represent the occurrence or non-occurrence of some outcome event, usually coded as 0 or 1) and the independent (input) variables are continuous, categorical, or both. As you can see from the formula p is the probability that Y=1 and X₁, X₂,...,X_k are the independent variables (predictors). b₀, b₁, b₂, b_k are known as the regression coefficients, which have to be estimated from the data. Logistic regression estimates the probability of a certain event occurring. Finally, the farmers were categorized according to the factors affecting to the adaption level.

Description of experimental site in Tashkent region

Tashkent region is located to the north-east of Uzbekistan which is surrounded by Chatkal, the Pskom and Ugom mountain chains from north-east and east. It is located 350-500 meters above the sea level in the northeast part of Uzbekistan between the western slopes of the Tyanshan mountain ranges and the Syrdarya River. The primary water source is the Chirchik River that springs in the mountains in Kirgezistan and traverses the oblast. It is tributary of the Syrdarya River. The total area of Tashkent covers 15.300 square kilometers.

The climate of the region is sharp continental, with mild winter and long dry summer. The average temperature in January is usually around -1 to -2, and in June - about +27 degrees. Plain areas receive about 250 mm of annual precipitation, and the vegetation period covers approximately 210 days. The sunshine period totals 2889 hours during a year. The soil of Tashkent region is mainly servozem (grey loamy) and represents majority of plowed lands.

RESULTS AND DISCUSSIONS

Some factors commonly found in the literature to be related with the adoption of soil conservation fall into two categories: (1) individual level or farm household characters of the farmers including *age*, *education*, *knowledge level*, *awareness*, *attitude toward conservation practices*, *motivation*, etc. (2) farm structural or biophysical factors related to the adaption of conservation practices including *farm size*, *income*, *farm profitability*, *tenure*, ect. In order to measure the adoption level of sustainable soil conservation practices such as *crop land area*, *crop yield*, *soil moisture*, *bulk density*, *soil humus*, *and finally*, *farm financial characteristics; farm income*, *off farm activities*, *employment*, and *agricultural machinery*, were applied in the questionnaire for input data of model estimation.

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Variables	В	S.E.	Wald	Sig.	Exp(B)	Rank
Crop Land	0.154	0.189	0.661	0.416	1.166	1
Employment	0.128	0.528	0.059	0.808	1.137	2
Education	0.113	0.844	0.018	0.894	1.119	3
Bulk density	0.58	0.39	2.209	0.137	1.06	4
Farmer's age	0.55	0.063	0.775	0.379	1.057	5
Crop yield	0.004	0.003	2.087	0.149	1.004	6
Soil moisture	-0.002	0.003	0.712	0.399	0.998	7
Soil Humous	-0.312	5.091	0.004	0.951	0.732	8
Off farm activities	-0.426	1.076	0.157	0.692	0.653	9
Constant	-24.375	10.14	5.778	0.016	0	0

Table 1. Logistic regression model output to estimate factors' priority

The estimated logit model correctly predicted and classified 82% of farmers' reactions (Figure 1). Table shows that satisfying farmer demands *LAND* or size of farm accompanied with related *EMPLOYMENT RATE* is one of the most important variables for adoption of CA. If farm's farm size is taken into consideration, adoption level would be increased. As a result of participation, suspicious and hesitations on CA adaption are overcome, consequently reliability will be increased. According to farmers' consideration to apply alternative/new technology and arming whole farming infrastructure with new agricultural and agronomic management is not worthy enough for small scale farms. Small size of farmers has less financial ability and can't afford to invest great amount of budget for innovation costs itself, without any additional support.

Another important factor is the accessibility to fundamental soil parameters such as *SOIL_MOISTURE* and *SOIL HUMOUS*. In Uzbekistan condition water scarcity and soil degradation are the key problems for agriculture sector. Due to these problems the agricultural production reduced up to 20-30% and this indicator is even increasing continuously. So this problem is the next motivation for farmers to shift to alternative way of cultivating which increase in water use efficiency and soil fertility while preserving the external inputs and other resources.

The model outputs also revealed that the *OFF FARM ACTIVITY* is the next factor that constraint the farmer's adaption. Farmers who have additional business besides farming activity have no much

interest to adopt alternative technology. Because the income coming from the farming is not significant enough and most farmers spend their spare time for gardening and farming. In their consideration, application of new agronomic practices requires extra afford and time consuming process to deal with. So this group of farmers is staying still with traditional way of agriculture. The farmer who can't obtain expected amount of yield has no choice to change the way of agricultural operation .So these are prior factors farmers to adapt alternative sustainable technology to find a solution for the current agricultural problems.



Figure 1. Success rate of Conservation Agricultural adaption

According to the final result of model estimation, the probability of overall success rate is equal to 82%. Out of 20 observed farmers, who adopted CA practices, 15(75%) are succeeded with (P<0.5) higher probability indicators, however 5 farmers showed negative results (figure 2). The prediction for 30 not-adapted farmers indicated that 26(86.7%) farmer possesses higher probability to adopt new technology. Only 4 farmers probability rate to adoption was lower than restriction line (P<0.5).

The table depicts the list of the farmers with low rate in success with CA and not adopted farmers with low probability to predict the adaption of CA technology. It can be noticed that these group of farmers mostly who have additional business and have small area of agricultural crop land.

CONCLUSION

In this study, factors that affect the adoption of CA by farmers are evaluated using logistic regression model and results are presented. These results are considered to prove useful in creating projects that optimize farmer satisfaction. According to these results, the most important factors discovered in CA adoption are: *LAND_SIZE, SOIL MOISTURE, SOIL, HUMUS* and *OFF FARM ACTIVITIES*. Innovation adoption is faster and more frequent among farmers with a higher level of education, interested in land acquisition to increase their farm size and on farms with a better structure. Out of all personal characteristically factors which are hypothesized the land size is likely to have an impact

upon the adoption of best practice in agriculture and showed positive correlation to the adoption. Social participation such as membership in local organization has a positive relation with the use of conservation practices if the government supports the development of CA technology. Communication and linkage between landholders and other activities may increase the adaption rate as well. Hence, participation in extension-education courses, using level of information sources and communication channels are considered preliminary step for better implementation of CA. It would be helpful if the government encourages the use of CA practices to enhance agricultural production of salt- and drought-affected regions, and continues the promotion of CA in dryland areas. Training and advocacy materials should be developed for promoting CA practices in different type of crops, especially cotton and wheat.

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