# Influences of Value Perception on Farmers' Technology Adoption Tendency and Conditional Response-Based on the Micro Data of 338 Farmers

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**ABSTRACT**

From the "perception-action" perspective, based on the microscopic survey data from 338 farmer households, this paper measures the influences of farmers' value perception on their tendency to adopt technologies using a combination of methods including the confirmatory factor analysis and multi-group structural equation model and further studies the response of each influence path on variables like the characteristics of the individual decision maker, topographic conditions, radiation circle, and whether the farmer has joined any agricultural organization. The results show that: (1) anticipated benefit and comprehensive value perception have significant positive influences on farmers' tendency to adopt technologies; and cost and benefit risk perception have negative inhibitory effects on their adoption tendency; (2) The individual characteristics of the farmer household decision makers have a significant role in adjusting the perception of comprehensive technological value and its influence on the adoption tendency; (3) the influences that farmers' knowledge of technology costs and benefits and their perception of health risks have on their adoption tendency show significant geographical responses; and (4) whether the farmers are members of agricultural organizations (leading enterprises) leads to large differences in the influences that farmers' value perception has on their technology adoption tendency.



**Key Words:** Technology Perception, Adoption Tendency, Conditional Response, Farmers, Structural Equation Model

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## Introduction

With the development of the product supply systems, the improvement of the consumer income level and the diversification of consumer values, the factors that influence the decisions of buyers have shifted from the utility functions of products to a complex integrated system consisting of functional, psychological and environmental factors, and buyers' subjective judgments tend to play a more and more important role. Therefore, in recent years, it has been a focus of the consumer behaviour research to study the buyers' decision making from the perspective of value perception. As the ultimate decision makers and executors of agricultural production, how do farmers evaluate the values of new technologies and perceive their risks and what is their adoption tendency? What are the conditional differences in the influences of value evaluation and risk perception on farmers' technology adoption decisions? The answers to the above questions help clarify the reasons for the low rate of technology adoption by farmers from the perspective of subjective motivation and are of certain theoretical and practical significance to exploring how to increase farmers'

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initiatives to apply technologies and solve the "last mile" problem in agricultural technology promotion (Long, 2015; Simtowe *et al*. 2016).

Researchers have done a lot of discussions on farmers' technology knowledge, evaluation and adoption. The research focuses on the following aspects: farmers' motivation and willingness to adopt technologies, including their demands for specific crop technologies and the sequence of these demands (Man *et al*., 2011; Lu *et al*., 2011), and the influencing factors to farmers' willingness to adopt technologies (Yu *et al*., 2013; Awotide *et al*. 2016); the influencing factors to technology adoption, including policy, economic level, geographical environment, individual characteristics and other micro-environments (Zhao *et al*., 2012; Zhu *et al*., 2015; Binam *et al*. 2017; Bandewar *et a*l. 2017); the relationship between farmers' perception of climate changes and technology adoption (Deng *et al*., 2012; Jin Leshan *et al*., 2014; Simtowe *et al*. 2018). The research on farmers' behaviours from the perspective of perception more focuses on other aspects, such as farmers' perceptions of agricultural risks and the influencing factors thereto (Ye *et al*., 2014), the relationships between government behaviours and farmers' insurance awareness and decisions and between agricultural insurance and farmers' livelihood (Zong *et al*., 2014; Tian *et al*., 2015) as well as the value of the conversion from farmland to non-farm land (Ma *et al*., 2016), perception and action of homestead exit (Zhu *et al*., 2016) and the expectations for the benefits of rural tourism and cultural heritage protection (Zhang *et al*., 2017).

Through review of these literatures, it can be seen that few research has been conducted on the correlation between farmers' perceptions of agricultural technologies and their adoption behaviours from multiple dimensions. This paper, based on the relevant results of the research behaviour research, proposes some concepts like farmers' comprehensive perception of agricultural technology value and its associated dimensions and farmers' technology adoption tendency and sets appropriate scales and performs preliminary quantitative measurement and exploration of how much each dimension of the comprehensive value perception influences farmers' technology adoption tendency and the conditional differences in these influences.

## Concepts and hypotheses

The theory of reasoned action believes that an individual behaviour occurs under the behavioural intention, and that the behavioural intention is mainly a result of the interactions between evaluation criteria and behavioural attitudes. A farmer's comprehensive perception of technological value refers to his/her estimation of the input-output performance of a certain agricultural technology based on the crop growth habits, market supply and demand conditions; regional agricultural production environment and his/her own technical proficiency. It is the internal factor that affects whether or not the farmer will decide to adopt the technology. A farmer's technology adoption tendency refers to the probability that the farmer decides to adopt the technology after evaluating the values of the variety replacement, crop farming, soil improvement and pest control technologies available. Considering there are multiple dimensions in the technology perception of farmers, this paper attempts to measure from 4 aspects, namely anticipated benefit of the technology, cost perception, benefit risk perception and health risk perception, and puts forward the following hypotheses:

(1) Relationship between each dimension of farmer's value perception and their comprehensive value perception

Hypothesis 1: the anticipated benefit of the technology has a positive influence on the comprehensive value perception;

Hypothesis 3: the awareness of the technology cost has a negative influence on the comprehensive value perception;

Hypothesis 5: the perception of the benefit risks of the technology has a negative influence on the comprehensive value perception;

Hypothesis 7: the perception of the health risks of the technology has a negative influence on the comprehensive value perception;

(2) Relationship between each dimension of farmers' technology value perception and their adoption tendency;

Hypothesis 2: the anticipated benefit of the technology has a positive influence on the adoption tendency;

Hypothesis 4: the awareness of the technology cost has a negative influence on the adoption tendency;

Hypothesis 6: the perception of the benefit risks of the technology has a negative influence on the adoption tendency;

Hypothesis 8: the perception of the health risks of the technology has a negative influence on the adoption tendency;

(3) Combining the above two parts, this paper proposes the final hypothesis:

Hypothesis 9: a high comprehensive perception of value can effectively increase farmer's technology adoption tendency

## Data Sources and Research Methods

### *Questionnaire design and data acquisition*

By reference to the measurement index systems in similar literatures, based on the information acquired from the semi-structured questionnaire survey and field interviews and through the preliminary research and expert consultation, the research team finally prepared a survey questionnaire containing 24 measurement indices. Except the attribute variables of the respondents, the questionnaire quantifies the 24 measurement indices using the Likert's 5-point scale – the degree of recognition expressed by the respondents ranges from 1-5 points. The data used in this paper were obtained by the research team during a one-to-one questionnaire survey in the main producing area of potatoes in Dingxi in October 2016. The main technologies applied in potato planting include deep ploughing and soil preparation, fertilizer preparation, seed selection and slicing for breeding, sowing and field management. The technologies involved in this questionnaire are the key parts of these processes, including the application of deep furrow and high ridge, virus-free potato seed, mulching film and fertilizers and pesticides. Considering their connections with the regional technological centre, Dingxi District, Lintao County and Tongwei County were considered as Level 1 radiation zones and Yuzhong County and Weiyuan County as Level 2 radiation zones. Two towns (townships) were selected from each county (district) so that there were a total of 10 towns (townships) in the sample area.

### *Research method*

The structural equation model has a unique advantage in measuring the complex relationships between multidimensional observational variables and latent variables and further exploring whether there is any correlation between the latent variables. According to the previous theoretical analysis, it can be seen that farmers' technology perception is a comprehensive subjective impression influenced by multidimensional variables. To explore its influences on the choices of technologies, researchers must find the latent variables based on a large number of basic observational variables and examine their relationships. Therefore, in this paper, the research team used the software Lisrel8.7 to run the structural equation model for measurement and analysis.

The relationships between the observational variables and the latent variables are expressed in the following measurement equations:

$$\underset{(q\times1)}{x} = \underset{(q\times n)}{\Lambda_x}\ \underset{(n\times1)}{\xi} + \underset{(q\times1)}{\delta}$$

$$\underset{(p\times1)}{y} = \underset{(p\times m)}{\Lambda_y}\ \underset{(m\times1)}{\eta} + \underset{(p\times1)}{\varepsilon}$$

where, $x$ is the $q$*1 vector consisting of $q$ exogenous observational variables; $y$ is the $p$*1 vector consisting of $p$ endogenous observational variables; $\xi$ is the $n$*1 vector consisting of $n$ exogenous latent variables; $\eta$ is the $m$*1 vector consisting of $m$ endogenous latent variables; $\Lambda_x$ is the $p*m$ factor loading matrix of X on $\xi$; and $\varepsilon$ is the measurement error.

The relationship between the latent variables is expressed in the following structural equation:

$$\underset{(m\times1)}{\eta} = \underset{(m\times m)}{B}\ \underset{(m\times1)}{\eta} + \underset{(m\times n)}{\Gamma}\ \underset{(n\times1)}{\xi} + \underset{(m\times1)}{\zeta}$$

where, $B$ is the interaction coefficient between endogenous latent variables; $\Gamma$ is the path coefficient of the exogenous latent variables with respect to the endogenous latent variables; $\zeta$ is the residual vector of $\eta$, reflecting the unexplained part.

Based on the above, this paper proposes two concepts–farmers' comprehensive perception of agricultural technology value and their technology adoption tendency. It takes the 4 measurement dimensions of the comprehensive perception of technology value as exogenous latent variables, applies the structural equation model to measure the influences of relevant observational variables on the corresponding latent variables, summarizes the influences of anticipated benefit, cost awareness and risk evaluation on farmers' comprehensive perception of agricultural technology value and their technology adoption tendency and then further studies the effects of different variables on the effective paths.

## Measurement of the influences of perception on the adoption tendency

### *Basic characteristics of the respondents*

In this survey, a total of 380 questionnaire forms were sent out and 363 were recovered. Due to the low literacy of the respondents, nearly a third of the questionnaires were completed in the form of semi-structured interview, leading to a high recovery rate of up to 95.26%. In order to ensure the quality of the basic data acquired, the research team checked in the integrity and logicality of the indices in the recovered questionnaires and finally obtained 338 valid questionnaires, achieving a valid recovery rate of 88.95%. The statistical results are shown in the table below.

### *Model estimation, evaluation and correction*

According to the reliability and validity analysis, the overall α coefficient of the questionnaires was 0.852, and the KMO coefficient 0.803, indicating that the data obtained from the questionnaires were highly reliable and valid. Furthermore, through the confirmatory factor analysis, 3 variables with a factor load of less than 0.5 were deleted, so in the adjusted scale, there were 21 observational indices. The team used *Lisrel*8.7 to perform path setting and verification in the structural equation model. The results show that the factor loads of the 21 observational variables on their corresponding latent variables were all above the critical level 0.5. Among the path coefficients between the latent variables in the structural model, 6 coefficients had an absolute value of above 0.5, and the absolute T value also exceeded 1.96, which means, 6 out of the 9 paths passed the hypothesis test. In terms of the 3 fitting indices for evaluation of the structural equation model, the $\chi^2/df$ index, which could be greatly affected by the sample size, got a score of 2.402, which was less than the upper limit 3 and reached a good level. The *GFI* score was 0.907, indicating that the survey data were in a good match with the designed path map. The *RMSEA* index also reached the desired interval of 0.05-0.08. The parsimony fit index and the incremental fit index also basically reached or were close to their tolerance limits. So the initial model generally met the relevant parameter requirements. In accordance with the principle of minimizing the T value, the research team started deleting one by one from Hypothesis 3 and re-ran the program and finally obtained the full model, as shown in Figure 1.

### *Model results and overall effect analysis*

By summarizing the path coefficients of the latent variables in Figure 1, the research team obtained the direct effects, indirect effects, overall effect and final test conclusions, as listed in Table 2.

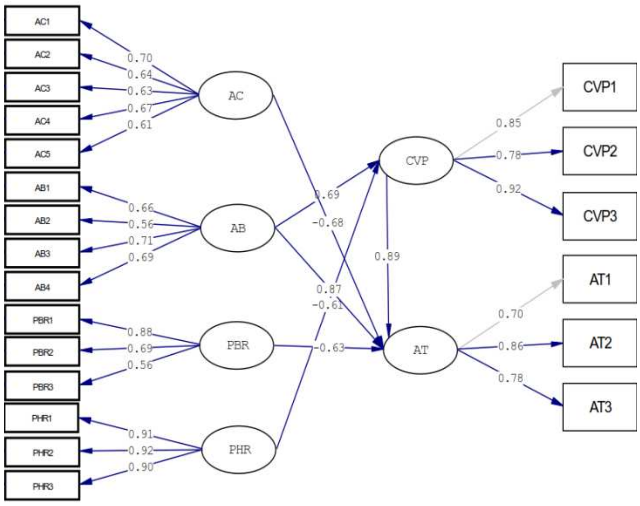


**Figure 1.** Modified structural model for factors influencing the tendency to adopt agricultural technologies

*Note: AB, CVP, AC, PBR, PHR, AT are the abbreviation of anticipated benefit, comprehensive value perception, awareness of the technology cost, perception of the benefit risks, perception of the health risks, adoption tendency*

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**Table 1.** Characteristics of the respondents

| variable | group | Number | Frequency (%) | variable | group | Number | Frequency (%) |
|---|---|---|---|---|---|---|---|
| sex | male | 282 | 83.43 | topography | mountain | 224 | 66.27 |
| | female | 56 | 16.57 | | plain | 114 | 33.73 |
| age | under 45 | 83 | 24.56 | radiation layer | one-level | 213 | 63.02 |
| | above 45 | 255 | 75.44 | | two-level | 125 | 36.98 |
| education | low | 290 | 85.80 | participate cooperative | yes | 141 | 41.72 |
| | high | 48 | 14.20 | | no | 197 | 58.28 |

*Note: considering the education level of the agricultural labour force in the research area, those only with junior high school education and below are considered to be of low education background and those above junior high school education are considered to be of high education background*

**Table 2.** Effects between variables and test conclusions

| Research hypothesis | Direct effect | Indirect effect | Total effect | Result |
|---|---|---|---|---|
| H1:AB→CVP | 0.69 | — | 0.69 | support |
| H2:AB→AT | 0.87 | 0.61 | 1.48 | support |
| H3:AC→CVP | — | — | — | nonsupport |
| H4:AC→AT | -0.68 | — | -0.68 | support |
| H5:PBR→CVP | — | — | — | nonsupport |
| H6:PBR→AT | -0.63 | — | -0.63 | support |
| H7:PHR→CVP | -0.61 | — | -0.61 | support |
| H8:PHR→AT | — | — | — | nonsupport |
| H9:CVP→AT | 0.89 | — | 0.89 | support |

From the above table, it is easy to see that among the 9 hypothetic paths proposed in this study, the paths *H1*, *H2*, *H4*, *H6*, *H7*, and *H9* passed the significance test, meaning the following hypotheses are supported: (1) Farmers' anticipation of benefits from the technology and their perception of health risks influence their comprehensive value perception. The path coefficient of anticipated benefit with respect to the comprehensive value perception was 0.66 ($p<0.05$), indicating that anticipated benefit is the main factor influencing farmers' comprehensive value perception of a new technology. The negative path coefficient of health risk perception with respect to the comprehensive value perception was -0.58 ($p<0.05$). (2) farmers' anticipated benefit, cost awareness, benefit risk perception and comprehensive value perception all have significant influences on their adoption tendency. The path coefficient of anticipated benefit with respect to farmers' adoption tendency was 0.85 ($p<0.01$), showing that anticipated benefit has direct influence on whether the farmers will adopt the technology. The higher the anticipated benefit, the greater the possibility that the farmers will adopt the technology. Cost awareness and technology risk perception have negative influences on the use of technology. Their path coefficients were -0.63 ($p<0.05$) and -0.57 ($p<0.05$), respectively, which means, if the farmers think applying a new agricultural technology is costly or they are not certain about the benefit of the technology, this will have a great negative influence on whether they will adopt the technology. The path coefficient of the comprehensive value perception with respect to the technology adoption tendency was 0.87 ($p<0.05$), indicating that the comprehensive value perception is the key variable that influences whether the farmers will adopt the technology.

## Conditional responses of the influences of value perception on the adoption tendency

In this section, multi-group model validation is performed on the factors influencing farmer's technology adoption tendency with *AMOS18.0*, and the results show that 5 paths have conditional responses. Details are shown in Table 3.

(1) In terms of individual characteristics, variables like gender, education background, radiation circle where the farmer is located and whether the farmer is a member of an agricultural cooperative or a base member of a science park result in significant differences on path H1. Most of the male farmers and those with high education background are more objective and have better judgment on the anticipated benefits of technologies than female farmers and those with low education background, and therefore these variables result in significant differences in the positive influence path of the anticipated benefit with respect to comprehensive value perception. Level 1 radiation zone also has a significant effect on this path, because according to the Tobler's First Law of Geography, the closer a farmer is to the



**Table 3.** Response coefficients of the paths

| Hypothesis | sex | | age | | Educational level | |
|---|---|---|---|---|---|---|
| | male | female | Under 45 | Above 45 | low | high |
| H1 | 0.529** | 0.294 | 0.476 | 0.328 | 0.309 | 0.296** |
| H2 | 0.801*** | 0.257 | 0.341** | 0.209 | 0.347 | 0.698* |
| H4 | 0.207 | 0.235** | 0.226 | 0.316** | 0.219 | 0.379 |
| H6 | 0.305 | 0.616** | 0.226 | 0.405* | 0.593 | 0.427** |
| H7 | 0.326 | 0.317 | 0.367** | 0.196 | 0.386 | 0.498* |
| Hypothesis | topography | | radiation layer | | Participate cooperative | |
| | mountain | plain | one-level | two-level | yes | no |
| H1 | 0.336 | 0.217 | 0.639* | 0.428 | 0.617* | 0.299 |
| H2 | 0.378 | 0.265 | 0.314* | 0.261 | 0.415** | 0.120 |
| H4 | 0.565* | 0.308 | 0.513 | 0.372 | 0.418 | 0.377 |
| H6 | 0.671** | 0.499 | 0.286 | 0.377 | 0.364** | 0.479 |
| H7 | 0.536 | 0.473** | 0.395 | 0.418 | 0.429** | 0.265 |

*Note: * means p<0.05, ** means p<0.01, and *** means p<0.001* agricultural science and technology park, the more access he or she will have to the technological demonstration and promotion and trial planting of new varieties. Being a member of an agricultural cooperative or a base member of a park also has a significant effect. Official agricultural production organizations like agricultural cooperatives not only provide members with technical guidance or sales network construction services, but also improve farmers' knowledge of technological benefits by various means, and members of these cooperatives also carry out unofficial communications between each other, so this variable is very significant in path H1.

(2) The 3 variables in individual characteristics, the radiation circle where the farmer is located and whether the farmer is a member of an agricultural cooperative or a base member all play significant roles in path H2. From the analysis on the influencing factors to path H1, it can be easily seen that, male, young and highly educated farmers can have much clearer judgment on the anticipated benefit of a technology and are also more decisive than female, elder and poorly-educated ones. Therefore, these variables have significant effects on the positive influence of anticipated benefit on farmers' adoption tendency. Being close to an agricultural science and technology park or serving as a member of an agricultural cooperative or base member of a leading enterprise gives a farmer the advantages in technical consultation and marketing and allows him or her to directly see the real benefits brought by technologies, and being member of a group also brings internal pressure and herd effect on him or her, making him or her more easily perceive the high benefits from the technologies and thus more decisive in adopting these technologies.

(3) On the negative influence path of cost awareness with respect to the adoption tendency, only 3 variables – gender, age and terrain have significant effects. Women are more careful than men when it comes to the decision on spending. For a newly emerging technology, its benefit is not validated, so the uncertainty in return will significantly reduce women's intentions to adopt the technology. Elder people tend to be more sensitive to cost, so age also exerts a significant effect on this path. Farmers in mountainous areas are mostly pure farmers who live by agricultural production. Due to limited family income, these farmers care much about the cost of the technology and are not so enthusiastic about applying a costly one.

(4) Judging from the 6 hypothetic paths, female and elder farmers are risk averters, so when making a decision about a technology with benefit risks, they tend to be more affected by their perception of the risks than male and younger ones. Highly-educated farmers pay more attention to the environmental effect of agricultural production and prefer environmental-friendly agricultural technologies, so they may resist those that may bring environmental pollution to soil and water. Farmers in mountainous areas, due to their high reliance on agricultural production, are very concerned about the benefit risks of technologies like the environmental effects, product sales and price. Once the benefit risks reach their tolerance thresholds, their tendency to adopt the technologies will be significantly reduced. Farmers serving as members of agricultural cooperatives or base members of leading enterprises have relatively high awareness of environmental protection, so they will also reduce the application of a technology if they recognize any possible risk associated with it.

(5) On the negative influence path of health risk perception with respect to the adoption tendency, age and education exert significant effects. Young and highly-educated farmers will be very resistant to those technologies with great health risks because they attach high importance to their own health and also the public health. Farmers in plain are exposed to more agricultural product quality problems and information, so they understand that the safety and quality problem of an agricultural product will damage the reputation of the product in the market and bring huge losses to its sales. So radiation circle plays a significant role in this path. Whether being a member of any agricultural cooperative or leading enterprise also brings significant differences, because during the cooperation with the agricultural organizations, farmers can receive more training and education on agricultural product quality and safety and their agricultural production operations are also subject to the supervision and inspection by most of the organizations, prompting them to follow the mandatory requirements for agricultural product quality and safety.

## Conclusions

This paper constructs a framework for studying on the influences of farmers' technology perceptions on their technology adoption tendency. Based on the field survey data from 338 potato farmers in Dingxi, Gansu, this paper measures the levels of the two on various dimensions and uses the structural equation model to explore the influences of farmers' technology perceptions on their technology adoption tendency and their conditional responses. The main conclusions are as follows:

(1) Farmers have high perception of the comprehensive value of agricultural technologies and have high tendency to adopt them, but there is still great space for improvement; (2) anticipated benefit and comprehensive value perception have significant positive influences on farmers' tendency to adopt technologies, and cost and benefit risk perceptions have negative inhibitory effects on their adoption tendency; (3) the 3 individual characteristic variables of farmer household decision makers have significant adjusting effects on the influence paths of the technology value perceptions with respect to farmers' adoption tendency; (4) geographic environment variables have significant effects on the hypothetic influence paths of farmers' technology value perceptions with respect to their adoption tendency; (5) there are also responses from the production and operation mode in all hypothetic influence paths of farmers' technology value perceptions with respect to their adoption tendency.

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