

## **A MULTINOMIAL APPROACH FOR ORGANIC AGRICULTURAL PRODUCTION PRACTICES ADOPTION VIS-À-VIS SOCIO-ECONOMIC AND ICT DETERMINANTS**

M. Aslam<sup>1,2</sup> and Z. Li<sup>1\*</sup>

<sup>1</sup>School of Management, Jiangsu University, Zhenjiang, Jiangsu, China

<sup>2</sup>Department of Agribusiness and Entrepreneurship Development, Muhammad Nawaz Shareef, University of Agriculture, Multan, Pakistan

\*Corresponding Author's E-mail: zhiwenli@ujs.edu.cn

### **ABSTRACT**

Organic agricultural production practices are generally often regarded environmentally and eco-friendly compared to conventional methods, primarily because they prevent the use of synthetic pesticides, herbicides, and fertilizers that may have untoward effects on human health and the environment. It lessens the risk of chemical residues in soil and food. Farmers' decision about organic farming practices is important due to several factors mainly the consumer demand for organic products continues to rise, organic farmers often receive premium prices for their produce and potentially enhance their own economic viability. So, the farmers' decision play an imperative role in the adoption and diffusion of organic farming practices. However, these factors and their effects remain untapped for the organic production practices. The study identified the factors affecting farmers' decision to adopt organic production technology particularly in context of socio-economic and information and communication technologies (ICTs). A sample of 300 respondents were selected by using a purposive random sampling technique from villages of Lahore Pakistan. The outcomes obtained through the multinomial regression technique revealed that literacy level of farmers, access to ICT tools, access to credit, membership in farmers association, contact with food super stores, no use of chemicals, participation of farmers in training programs were influencing the farmers' adoption decision to adopt organic production practices significantly. Thus, the research recommends that government officials, policy makers, farming community and agribusiness value chain actors should consider these traits when promoting smart agricultural practices to improve the well-being of associated stakeholders. Certainly, initiating awareness campaigns and pilot projects with joint involvement of public and private sectors may be highly effective in educating farming communities. Ultimately, the outcomes of this research work may navigate behavioral and cognitive dynamics to facilitate the adoption of organic production practices within the farming community.

**Key words:** ICT tools, organic production technology, smart agricultural practices, agribusiness value chain, farmers association

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### **INTRODUCTION**

Ensuring access to food is a key concern for all nations and regions worldwide. Consumers are also becoming more aware of food safety issues and changing their preferences accordingly. This trend is evident in Pakistan as well, where the demand for organic food is increasing (Aslam *et al.*, 2017; Michaelidou and Hassan, 2010; Micheaelidou and Hassan, 2008). Modeling the factors affecting rural consumers' purchase of organic and free-range produce: A case study of consumers from the Island of Arran in Scotland, UK. *Food Policy* 35:130–139. Organic farming, which relies on natural inputs and avoids synthetic fertilizers and pesticides, can contribute to a sustainable environment, and produce healthy crops and animals (Stoleru *et al.*, 2019).

Agriculture is a key sector and a mainstay of Pakistan's economy. It has undergone several structural changes since the country gained independence in 1947. However, its share in the Gross Domestic Product (GDP) has been steadily decreasing. Agriculture still accounts for 22.9% of the GDP and it employs 37.4% of the labor force (Government of Pakistan, 2023). This sector primarily provides cereals, fiber-based crops, fruits, vegetables, and condiments. Vegetables provide fiber and nutrients essential for health (Ureña, 2008; Aslam & Rasool, 2013). Pakistan has rich soil and a suitable climate to grow more vegetables and meet the increasing demand for processing industries. The main challenge that the farmers face is low prices during the harvest season due to oversupply. The excessive use of pesticides and synthetic fertilizers in the production of crops is also

a significant concern for consumers nowadays. Therefore, farmers may adopt innovative production methods to improve productivity and use effective marketing methods to increase profit and provide healthy and safe food for consumers (Akram *et al.*, 2021; Abid and Shang, 2021).

In emerging economies, the agriculture sector contributes a significant role in improving socio-economic status of the communities as alleviation of poverty and creation of employment opportunities that lead to economic well-being in the societies (Methorst *et al.*, 2017). In Pakistan, areas near the cities are often used for vegetable production, close to vegetable markets. Traditional unclean production practices may be discarded. These harmful production practices for example the usage of toxic pesticides and chemicals to accelerate the yield of vegetables and protect crops from pests, compromise human health and raise the level of diseases, and most of the citizens are regularly consuming these unsafe vegetables in Pakistan (Aslam and Rasool, 2013). Modern technology is available to help farmers to produce the quality oriented organic vegetables, this produce is beneficial or good for health. Inorganic production is considered threats to human life. Many reports show concerns about human health and the environment due to the usage of chemicals present in the vegetables. Most farmers use traditional organic practices in production, but these methods are not according to international standards. Consumer demand and interest in organically grown food create new avenues for the markets and entrepreneurs (Srienieng and Thapa, 2018; Wang and Somogyi, 2017; Alizadeh *et al.*, 2008).

Organic agricultural production is environmentally and eco-friendly as it prevents the use of elements dangerous to human health (Urrea-Hernandez *et al.*, 2016). The food is produced and distributed in a conventional way in Pakistan, though with technological innovation and changes in consumer choices, the fashion of prudent, healthy, and nourishing food is gradually enhancing. The primary organic vegetables are grown in the country viz. potato, capsicum, ginger, garlic, carrot, and tomato. However, organic production in Pakistan is done at a smaller level but situation is altering in a reaction to augment the significance of organic produce. These organic commodities are considered better in terms of quality than traditionally grown vegetables as these vegetables are also considered prudent for a healthy life, safe and nutritious (Razzaq, 2011; Aslam *et al.*, 2017; Aslam and Akhtar, 2018).

According to Piyasiri and Ariyawardana (2002), the organic vegetables are essential for health, nutrition and food security and have emerging markets worldwide. Similar findings are also available from the studies of Xie *et al.* (2022), Zhang *et al.* (2018), Zhang *et al.* (2017), Methorst *et al.* (2017) and Verhees *et al.* (2012). Shafie and Rennie (2012) stated that consumers prefer to have a

decision to make between sustainable and non-sustainable products. To assess a commodity and reach a choice, consumers interrogate the information about its attributes and results of the products. Consumers' significance and standards helped to determine the importance of each driver. The experience fosters personal significance and interest, leading to motivational states. The organic consumer profile is augmented by demographic drivers, lifestyle, status, and environmental factors. Organic foodstuff consumers were more likely to be well-educated, prosperous, and have a higher social status or status conscious (Schröder, 2023). Awareness of food quality knowledge and risks about food quality hazards or risks were more common among women and persons having significant income and qualification levels. Lockie *et al.* (2002) discovered a substantial similarity between improving organic consumption and formal schooling. Srienieng and Thapa (2018) stated important drivers affecting customers' perception of the environmental impacts of organic production and the well-being gains of using organic agricultural produce.

The novel facet of this study is that it exhibits a dynamic approach to the determinants influencing farmers' decision to adopt organic vegetable production during a specific time frame. We segregate the respondents (farmers) into three particular categories. The respondents who have adopted organic vegetables production from last 5 years or more, namely early adopters, the respondents who have adopted organic vegetables production from last 1 year or above, namely later adopters whereas respondents who have adopted organic vegetables production less than 1 year, namely late adopters. The almost same kind of categorization has been used in the studies of Ullah *et al.* (2023) and Shah *et al.* (2023).

The rest of the article follows as second segment portrays the materials and methods, third segment explains the results and discussion and fourth segment concludes the findings.

## MATERIALS AND METHODS

**Theoretical framework:** According to the available data, explaining theory of diffusion of innovations, farmers adoption and willingness to grow organic produce is a relatively a emerging domain of study in Pakistan. There is the availability of limited literature for this research. However, even so, an effort has been made to analyze the available relevant works from Pakistan and other countries, which are as follows:

The theory of diffusion of innovations is the adoption of novel agricultural activities by the households, it was suggested by Rogers (Rogers, 2003). This theory is the foundation for evaluating the determinants of targeted respondents for their participation in novel activities of producing and

purchasing (Li *et al.*, 2018). This theory, the part diffusion inculcates the spread of novel activities from one person to the others who are interested in producing and purchasing of organic produce in the S-typed representation of the time frame (Rogers, 2003). Mainly due to time-based activity, efforts to accelerate the diffusion process of novel activities remain unsuccessful fail due to late adoption decisions of household heads (Cafer and Rikoon, 2018). This late adoption prevails due to many factors as lack of awareness and importance of innovation in the region. So, here the scanned literature highlighted the significance of organic vegetables for people.

The study proceeded mainly by doing face to face interviews with the vegetable growers for their adoption decisions of growing organic vegetables in Pakistan. Qualitative and quantitative research techniques were employed to comprehend the market potential of organic vegetables farming in the selected regions. Data was gained through structured, semi-structured, and non-structured in-depth interviews. Information was obtained about the main organic vegetables, viz. capsicum, cabbage, ginger, potato, okra, and tomatoes, grown in central localities of the country. The purposive random sampling method was employed to get sample because it is ideal in cases when the researcher has crystal clear purpose, and every individual has an equal chance of being selected. Guidance was sought to select samples from officials working in the public and private sectors. A sample size of 300 farmers were selected from major metropolitan district of Pakistan (Lahore district) randomly. In this regard, a guidance had been sought from the Department of Extension and Adaptive Research.

This sample size was determined employing the formula developed by Yamane (1967). The sample size based on this formula, widely used by the scholars (Ullah *et al.*, 2020; Asongu and Andrés, 2020; Boateng *et al.*,

2023; Shah *et al.*, 2023). The sample size for this study was determined at 10% confidence level.

The multinomial logistic analysis technique was opted as the respondents (farmers) were categorized into three segments viz. early adopters of organic vegetables, later adopters of organic vegetables and then late adopters of organic vegetables. Actually, this technique is used to determine the impact of major determinants in early adoption of organic vegetables (Ullah *et al.*, 2023; Shah *et al.*, 2023).

The equation (1) describes the probability of a respondent to adopt organic produce technology at a particular time frame *j* is the years of adoption as if respondent adopted the technology. The probable possibilities with which a respondent has a set of factors influencing the adoption of organic production technology in the early stages of adoption was modeled as:

The multinomial logit model formula is defined as:

$$P(Y = j | X) = e^{(\beta_j * X)} / \sum(e^{(\beta_k * X)}) \text{ for } j = 1, 2, \dots, J-1 \dots \dots \dots (1)$$

Where:

$P(Y = j | X)$  is the probability that the outcome is in category *j*.

$\beta_j$  is a vector of coefficients for category *j*.

*X* is a vector of predictor variables.

*j* is the total number of categories.

*j*=3 if the respondent has adopted the organic production technology from last 5 years or more; *j*=2, if the respondent has adopted the organic production technology from last 1 year or above whereas *j*=1 if the respondent has adopted the organic production technology from less than 1 year).

The almost same kind of categorization has been used in studies of Ullah *et al.* (2023) and Shah *et al.* (2023). This formula estimates the probability of an observation falling into each category, given the predictor variables *X* and the coefficients  $\beta$  for each category.

**Table 1: Questionnaire Items and Measurement Scale**

Acronym	Variable Description	Question	Measurement Scale
Adoption	Adoption of organic production technology by farmers	Have you adopted the organic production technology in farming? What is the level of adoption of novel ICT tools in agriculture? From how many years you adopted the organic production technology?	Categorical
Age	Age of the farmer	What is the age of the farmer?	Continuous
Literacy Level	Literacy level of the farmer	What is the literacy level of the farmer?	Continuous
Household members	Household members of the farmers	How many family members do you have in the house?	Continuous
Farming Experience	Experience of the farmer in agriculture	What is your total experience in agriculture? What is your experience in organic	Continuous

Cultivated Land	Total cultivated land owned by the farmer	production technology practice? How much area you have cultivated for agricultural activities?	Continuous
Access to ICTs tools	Access of ICT gadgets by the farmer for performing agricultural activities	Do you have access to ICT tools for agricultural activities? If yes, then type of ICT tools you are using for performing the agricultural activities?	Dummy Categorical
Access to Credit	Credit access to the farmer	Do you have access to credit facility? If yes, then have you availed the credit? What is the amount of availed credit for agricultural activities? What is the purpose of availed credit?	Dummy Continuous
Membership of Farmers' Association	Farmer's participation in farmer's associations for mutual gains	Are you part of any farmer's organizations or agricultural cooperatives	Dummy
Participation in Training Programs	Farmer's participation in training activities	Do you participate in ICTs training and outreach activities?	Dummy
Premium Price for Organic Vegetables	Fetching premium prices of organically sown crops in the study area.	Do you perceive that the fetching premium prices is the reason behind for the adoption of organic production technology?	Categorical
No Use of Synthetic Chemicals	No use of synthetic chemicals on organic produce vegetables/fruits organically sown crops	To what extent there is no use of chemicals on organically produced commodities?	Categorical
Contact with Super Food Chains	Farmer's contact/linkages with the food chains for marketing organic produce	Do you have contacts or linkages with the food chains for marketing of organically sown food stuff?	Categorical

## RESULTS AND DISCUSSION

Descriptive statistics of explanatory factors employed in the multinomial approach are given in Table 2. The average age of farmer who adopted organic production in the study area was about 45.62 years, having 30.46 years' experience in the field of agriculture. The average family members were about 10.89 members, having 5.31 number of years of schooling. The peasants who adopted organic production technology had 8.00 acres of their agricultural area. Among the peasant who adopted organic production technology, 59% reported access to ICT tools, while 48% of the peasants reported access to credit facilities in their localities. Among the peasants who adopted organic production technology, almost 47% reported that they were members of farming associations their rural based communities. In the similar manner, 59% reported participation of them in agricultural training programs were timely adoption organic production technology. About 56% of organic producers reported premium price was the reason of their adoption of organic production in agriculture. The farmers' who adopted organic production technology, 54% reported no use of synthetic pesticides on the organic vegetables, whereas 58% reported that they had contact with super food chains in the market for their timely adoption decision of organic production technology.

Variance inflation factor (VIF) is the method to assess the phenomenon multicollinearity in explanatory factors (Aslam *et al.*, 2017; Ullah *et al.*, 2023). These values for our taken independent factors were existed between 1.297 and 2.965, which implies that all these values are below the threshold level of 10 (Ullah *et al.*, 2023). Thus, we observed no problem of multicollinearity in our explanatory variables (Table 3). Moreover, early adopters of organic production technology in our study was 65 farmers (21.7%), later adopters of organic production was 155 farmers (51.7%) and late adopters of organic production was 80 farmers (26.6%) respectively (table 4).

The paper applied multinomial logistic regression technique to determine the drivers influencing the early adoption of organic production by farmers. Basically, the growers were grouped into three categories as early, later, and late adopters of organic production technology. The later and late adopters of farmers were taken as the reference group categories. The value of pseudo  $R^2$  was 0.557 depicted that our model captured 55.70% of the probability of peasant adopting organic production technology earlier and fits the data as well. The value of LR Chi-Square was also significant result at 1% ( $P < 0.05$ ), revealing that some regressor factors were sustained in the given model, profoundly influencing growers' adoption decisions for using organic production (Table 5).

**Table 2: Description of Variables, Measurement and Summary Statistics**

Factors	Description of Factors and Measurement Scale	Mean (Std. Deviation)
Age	Age of a farmer (years)	45.62 (11.89)
Literacy Level	Qualification of farmer (number of years in schooling)	5.31 (3.39)
Household members	Total members of family in a house (numbers)	10.89 (5.87)
Farming Experience	Total experience of the farmers in agriculture (years)	46 (10.75)
Cultivated Land	Average total cultivated area owned by the farmer (acres)	8.00 (5.37)
Access to ICTs tools	=1 if a farmer’s adoption has been influenced by availability of ICT tools, 0 otherwise	0.59 (0.42)
Access to Credit	=1 if a farmer’s adoption has been influenced by availability of credit, 0 otherwise	0.48 (0.39)
Membership of Farmers’ Association	=1 if a farmer’s adoption has been influenced due to membership in farmer’s association, 0 otherwise	0.47 (0.36)
Participation in Training Programs	=1 if a farmer’s adoption has been influenced due to participation in training programs, 0 otherwise	0.59 (0.42)
Premium Price for Organic Vegetables	=1 if a farmer’s adoption has been influenced for getting premium price for organic vegetables, 0 otherwise	0.56 (0.41)
No Use of Synthetic Chemicals	=1 if a farmer’s adoption has been influenced by no use of synthetic chemicals on these organic vegetables , 0 otherwise	0.54 (0.41)
Contact with Super Food Chains	=1 if a farmer’s adoption has been influenced by contact with major food super stores , 0 otherwise	0.58 (0.42)

Author’s own calculations

**Table 3: Variance inflation Factor (VIF) Analysis**

Factor	Tolerance	VIF
Age	.301	2.467
Literacy Level	.359	2.214
Household members	.209	2.663
Farming Experience	.637	1.317
Cultivated Land	.549	2.337
Access to ICTs tools	.714	1.297
Access to Credit	.416	2.570
Membership of Farmers’ Association	.466	2.125
Participation in Training Programs	.488	2.779
Premium Price for Organic Vegetables	.583	1.713
No Use of Synthetic Chemicals	.486	2.965
Contact with Super Food Chains	.667	1.778

Author’s own calculations

The farmer age was negatively associated with a grower’s decision to adopt organic production technology in the early stages of adoption. Previous literature by Ullah *et al.* (2023) and Shah *et al.* (2023) have given contrary evidence to this outcome. The researchers observed that farmers tended to use smart farming practices with early ages than the old ones. As, old farmers were usually reluctant to adopt new smart agricultural practices Ayim *et al.* (2022), Akmal (2021), Akram *et al.* (2021).

The literacy level of a farmer was significant and positively associated with farmers’ decision to adopt

organic production technology in the earlier stages at their farms. Thus, educated farmers were more likely to participate in the early adoption process rather than late adopters of organic production technology. It implies that a grower with high literacy level had adopted organic production technology earlier than the less educated farmers in the study area. Moreover, the farmers who were knowledgeable could make timely and rational decisions in organic agriculture. Our result is consistent with the results of Aslam and Akhtar (2018) and Shah *et al.* (2023), narrated that well qualified farmers were more likely to participate in early adoption of organic production practices.

**Table 4: Time-based comparison of farmers for adoption decisions to adopt organic production technology for organic vegetables**

Adoption category	Frequency (Percentage)
Early adopters of organic production technology	65.0 (21.70%)
Later adopters of organic production technology	155.0 (51.70%)
Late adopters of organic production technology	80.0 (26.60%)
Total	300 (100%)

Author’s own calculations

Access to ICT tool such as smart phones, internet connectivity, websites, applications and other Internet of Things (IoTs) contributed positively in early

adoption decisions of farmers for using organic production practices. It implies that the farmers who had access to ICT gadgets in their localities, these farmers were more likely to participate in adoption of organic agricultural practices at their farms in the earlier stages. This factor highlights the significance of information and communication technology in a recent times for receiving

and sharing of quickly and authentic information regarding novel production practices. The positive correlation of access of ICT tools and early adoption decision was reported in our article Ayim *et al.* (2022), Akmal (2021), Akram *et al.* (2021), Abid and Shang (2021).

**Table 5: Multinomial Logistic Regression Outcomes for Growers' Early Adoption of Organic Production Practices.**

Factor	Early Adopters of Organic Production	
	Coefficients	Standard Error
Age	-0.158*	0.021
Literacy Level	0.659*	0.181
Household members	0.063	0.049
Farming Experience	-0.029	0.055
Cultivated Land	0.111	0.155
Access to ICTs tools	7.47*	2.915
Access to Credit	2.187*	0.825
Membership of Farmers' Association	2.943*	1.562
Participation in Training Programs	1.227*	0.835
Premium Price for Organic Vegetables	2.517*	0.843
No Use of Synthetic Chemicals	0.573*	1.345
Contact with Super Food Chains	0.671*	1.545

LLog-likelihood value= 375.87, LR chi-square value = 167.75, Chi-square significant = 0.000, Pseudo R<sup>2</sup> = 0.557

Author's own estimations: \*Represent the significance level at 0.01 whereas \*\*shows the significance level at 0.10. Later and late adoption decision-making group is a reference category.

Our results identified that the farmers' adoption decisions to adopt organic production technology in the earlier stages were affected by the availability of credit. In other words, if the farmers had access to finance, then would be more likely to adopt organic production practices in the early stages. Thus, access to credit had a profound and positive impact in the growers' timely adoption of organic production practices. This finding is consistent with the results of Ullah *et al.* (2023) and Akram *et al.* (2021) who indicated that access to credit positively negatively affects farmers' timely adoption decision of novel agricultural practices as shown in Table 5.

Other important determinant of adoption decision of farmer's membership in the Farmer's Associations (FOs) or agricultural cooperatives. In our study, it was affecting positively and significantly to the adoption decisions of farmers to adopt organic farming practices for their agricultural activities in the study area. These associations at village level are developed to sort out the issues, understanding of market potential and precision farming practices. These associations are helping a lot to cater the problems faced by farming community at their own level. These outcomes are supported by the studies of Awotide *et al.* (2016), Awuor

and Rambim (2022), Ayim *et al.* (2022), Akmal (2021), Akram *et al.* (2021).

Participation of farming communities in smart agriculture and ICT based training programs also enhance their adoption decisions to participate in the robotic agricultural farming practices. Our analysis also showed the same trend, if farmers' participation increased in training and outreach activities then farmers' adoption decision also improved for adopting organic farming practices in the study area. It is also in line with the findings of Tefera *et al.* (2016), Melesse (2018), Khan *et al.* (2021), Khan *et al.* (2022), Kimbi *et al.* (2021), Awan *et al.* (2019). Higher prices of organic produce also boost farming community to grow organic vegetables. The findings of our study showed the similar pattern that premium prices lead towards earlier adoption decision of farmers to use organic production technology for their crops. The same was confirmed with the study of Ullah *et al.* (2023) and Aslam *et al.* (2017) and Shah *et al.* (2023).

No use of synthetic pesticides on organic vegetables also influenced positively towards farmers' adoption decision to adopt organic farming technology in the early stages of adoption decisions. These results are in line with the findings of Abid and Shang (2021), Aslam and Akhtar (2018) and Aslam *et al.* (2017).

Contact with food chain stores is an important determinant who influenced the adoption decision of organic production technology. If linkages of farmers with marketers improved then farmers' participation and adoption decision of organic technological innovations would improve more and more. The coefficient sign was positive and significant. This result was supported by the studies of Ayim *et al.* (2022), Akmal (2021), Akram *et al.* (2021).

**Conclusions:** The sustainable diffusion of organic production practices and its timely adoption by the farming community contributes a significant role in the success of smart agricultural initiatives. Growers' timely adoption of organic production practices may lead to high premium price of organic produce, income improvement, establishment of direct linkages with super food chain marketers. The study outcomes confirmed that age of farmer, literacy level of a grower, access to ICT tools, availability of credit, farmer's membership in the farmer's associations or farmer's cooperatives, participation of farming communities in smart agriculture and ICT based training programs, premium prices of organic produce, no use of synthetic pesticides on organic vegetables, contact with food chain stores were influencing the adoption decision of organic production technology significantly. Our outcomes have key practical implications for the diffusion of sustainable organic production practices among the farming community in the developing economies. The timely adoption of organic production practices may improve the overall well-being of rural masses. Therefore, it is crucial to boost growers' early adoption of these agricultural innovations. Policies makers should devise the policies that promote the timely adoption of organic production practice by considering the growers' decision-making mechanism and characteristics. Like, agricultural extension and advisory service providers may engage the rural communities in informal training and outreach activities for less educated farmers and inform farmers about the advantages of organic production practices in improving agricultural productivity and the farm net profit.

Indeed, considering farm-level heterogeneity and complexity is crucial for developing effective market management plans and enhancing technology adoption among farmers, particularly those facing challenges such as limited access to ICTs and capital. Advocate for supportive policies and regulatory frameworks that incentivize investment in agriculture, prioritize the needs of smallholder farmers, and promote inclusive market development. Finally, the availability of ICTs tools is influencing positively to farmers' timely adoption of organic production practices. Thus, the government should ensure the accessibility of internet connectivity in

the rural localities that assist the farming community in the diffusion of organic production technology.

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