

# The Effect of Adoption of Technology, Technology Diffusion, Human Capital, Formation of Capital and Labor Force in the Production of Agriculture Products in Iraq

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Any nation's economic growth directly depends on expanding its agricultural industry. Compared to the agricultural productivity of the United States and Canada, Iraq's agricultural sector is dated. This study investigates the impact of technology adoption, technological diffusion, human capital, capital formation, and labor force on farm product output in Iraq. Unlike previous studies on the agriculture industry, which relied primarily on secondary data from various reports and surveys, this study is founded on primary data. The adoption of technology, the diffusion of technology, and human capital can increase agricultural production in Iraq, according to this study. Substantial study results contributed to a powerful framework in the body of knowledge. This study's innovative theoretical and practical ramifications will increase the literature and the practices of agricultural practitioners in Pakistan. The study aims to boost agricultural production in Iraq by stressing technology.

**Key words:** Adoption of technology, technology diffusion, human capital, formation of capital, agriculture products

## 1. INTRODUCTION

Agriculture has a crucial role in the economy of any nation (Usman et al., 2021). Agriculture contributes significantly to the gross domestic products exported to overseas markets to generate foreign revenue for any nation (Uduji et al., 2021). Innovation in the agriculture sector promotes the agriculture industry's production expansion and sector development (Lavoie et al., 2021). Numerous causes contribute to the expansion of the agriculture industry, for which the participation of supporting industries is crucial (Usman et al., 2021). Iraq's economy is failing because of warzones and political upheaval (Lavoie et al., 2021). According to contemporary working standards, the destruction of the agriculture industry is not advanced. Lazaroiu et al. (2019) report that Iraqi farmers are not supplied with the facilities necessary for their innovative product development in the agricultural sector. In today's intense market competition, innovation plays a vital role in enhancing the performance of all industries.

Because improved machinery enables the agriculture sector to operate novelly, technology has altered the agricultural industry's traditional methods of operation (Xu et al., 2021). As a result of its facilitation of the US and Canadian agricultural sectors, technology is deemed to play a crucial role (Jung et al., 2021). Farmers that work

ingeniously to promote the agriculture industry have the greatest impact on the economy's expansion through agricultural products (Kant et al., 2022). Unquestionably, technological dissemination is essential for developing the agricultural sector in every nation, as the adoption of new techniques occurs in stages (Stephens et al., 2018). Human capital and farmers in the agriculture industry must have a constructive attitude toward the technological challenges that are advancing the sector (Zhou et al., 2022). For agriculture growth, the performance of formers that utilize technology in novel ways is superior to that of traditional formers that do not utilize technology (Sapbamrer et al., 2022).

Su et al. (2022) have found that the performance of the agriculture sector is directly proportional to a nation's economic growth. Olney et al. (2015) suggested that the government should provide the formers with modern technologies to enhance their job and performance in the farm industry. Chinese farmers use technology to increase agricultural output (Molina-Maturano et al., 2020). Agriculture's development has been facilitated by technology's efficacy, enabling farmers to produce more efficiently (Uduji et al., 2021). Indeed, Chrismanto et al. (2019) also stressed the importance of educating formers on the right use of technology for enhanced learning. Xu et

al. (2021) noted that farmers with innovation resistance are less productive in the agriculture sector's performance. Bruun et al. (2017) found that the agricultural workforce should be educated and have a good attitude toward using technology. Existing research has revealed diverse viewpoints regarding the performance of the agriculture industry.

However, the literature has disregarded the role of technology adoption, technological diffusion, human capital, capital development, and labor force in agriculture product production (Aacharya et al., 2020; Kant et al., 2022; Whitcraft et al., 2019). This study investigates the impact of technology adoption, technological diffusion, human capital, capital formation, and labor force on farm product output in Iraq. This study used a novel methodology, as most previous research on agriculture relied on secondary data from various reports and surveys. On the other hand, this research is based on the primary data collected by farmers in Baghdad, Iraq, to assess the agriculture sector's effectiveness with technology from the perspective of farmers. This study's innovative theoretical and practical ramifications will increase the literature and the practices of agricultural practitioners in Pakistan. The study aims to boost agricultural production in Iraq by stressing technology.

## 2. LITERATURE REVIEW

Human capital is essential for all industries (Kim et al., 2018). The efficiency of the worker force on any given farm can increase the output of the agriculture industry. Farmers in the United States are well-trained to work efficiently, which is essential for their superior performance (Mehmood et al., 2022). China's agricultural output depends on the quality of its labor force, as output increases when laborers work from the heart (Hutahayan, 2020). The resources are crucial for the agriculture sector's success since decisions are made based on resources and financial capital (Rego et al., 2010). The capital is required for workers to achieve better health and living conditions. The Canadian government subsidizes farmers to relieve them of the burden of capital for higher agricultural production performance (Kaye et al., 2017). In fact, with foreign direct investment in the agriculture sector, agricultural production increases, which is essential for exporting exported goods (Zia et al., 2021).

Similarly, investment in the agriculture sector boosts the production of agricultural goods, hence increasing agrotourism in Indonesia (Olney et al., 2015). Alternatively, the Thai government has invested in the agricultural industry to encourage agrotourism in the country (Stephens et al., 2018). The capital provided by the investors is essential for the farm labor force. The high wages of the labor force motivate them to perform well in agricultural output, which influences the country's economic performance (Uduji et al., 2021). Chrismanto et al. (2019) noted that the agriculture sector has a significant impact on economic sustainability, but that for agriculture sector production, investment in the labor force is required.

Hypothesis 1. The formation of capital and labor force has an impact on agriculture production.

Human labor and workforce are essential for the economic success of any nation (Kim et al., 2018). Agriculture production is enhanced in nations that educate their workforce to use digital equipment in the agricultural industry (Zia et al., 2021). Indeed, labor performance is vital for the farm industry, but compensation should be commensurate with market norms (Kaye et al., 2017). The human mind is essential for agricultural production, but the lack of emphasis on worker development has made it difficult for the Iraqi agricultural industry to increase economic growth (Hutahayan, 2020). Technology development is suitable for students and positively affects their personalities. China's workforce is exposed to all new technologies, and their attitudes toward innovation adoption are cultivated for enhanced learning and performance (Rego et al., 2010). The effective application of technology and the notion of technology diffusion are essential to developing contemporary technology for the production and expansion of the agriculture industry (Mehmood et al., 2022). Stephens et al. (2018) highlighted that effective human capital is necessary to apply agriculture technology in the agriculture industry appropriately. To lessen the perception of innovation dissemination, it is necessary to respect the workforce and improve their grasp of the technology.

Hypothesis 2. Human capital has an impact on agriculture production.

Today, technology has altered the old methods of conducting business in any corporation (Kant et al., 2022). Every nation's technological growth has a substantial impact on several industries. Agriculture sector technology is deemed essential since it enables the inventive growth of the economy (Jung et al., 2021). The performance of employees in the agriculture sector can be improved if the government provides them with the required facilities (Stephens et al., 2018). In the current competitive market, the efficiency of the agricultural sector's work has been improved by using sophisticated machinery, which is essential for capturing a large market share (Olney et al., 2015). There is no doubt that advanced agricultural technology is available in the modern world, but it is scarce in developing nations, posing a hurdle to their technical development (Molina-Maturano et al., 2020; Stephens et al., 2018; Uduji et al., 2021). Less agriculture-related technology is available to develop nations like Iraq to boost agricultural output (Zilli et al., 2020).

Similarly, these developing countries are not the epicenter of agricultural tourism, which poses a problem for their governments (Aacharya et al., 2020). Stephens et al. (2018) argued that technological innovation is essential for the production and performance of the agriculture sector in any nation. Kant et al. (2022) noted that the proliferation of technology had altered traditional work habits, resulting in new methods for the promotion and production of agriculture. Due to the widespread application of

technology in the agriculture sector in Russia, the agricultural industry contributes significantly to the country's economic viability (Jung et al., 2021).

Hypothesis 3. The adoption of technology has an impact on agriculture production.

Hypothesis 4. The adoption of technology has an impact on technology diffusion.

Modern agriculture production has access to technology, but technology adoption is not widespread (Jung et al., 2021). Farmers in developing nations are not exposed to technology because they believe it is not beneficial to them (Kant et al., 2022). Similarly, the adoption rate of technology in agriculture is low since small farmers lack the means necessary to apply the technology for production (Stephens et al., 2018). The countries that emphasize the use of technology and whose governments assist farmers in acquiring new machinery for agricultural expansion are technologically advanced and meet the technological needs of other nations (Uduji et al., 2021; Xu et al., 2021). Conversely, technology diffusion is widely accepted in modern nations because farmers are

increasingly interested in creatively using technology to create greater conveniences for the labor force (Usman et al., 2021). Utilizing technology in the agriculture industry necessitates skilled workers due to the high cost of the technology and the high cost of machinery damage in agricultural production. The first stage of technology dissemination, according to Kuo et al. (2022), is to raise awareness about the good applications of technology. Xu et al. (2021) noted that advanced nations are utilizing technology in a contemporary manner to increase agricultural output. Sekaran et al. (2021) stressed that the spread of technology in the agriculture sector promotes technology usage and the sector's growth. According to Jung et al. (2021), developing nations use technology for agriculture production on a lower scale.

Hypothesis 5. Technology diffusion has an impact on agriculture production.

Hypothesis 6. Technology diffusion mediates the relationship between the adoption of technology and agriculture production.

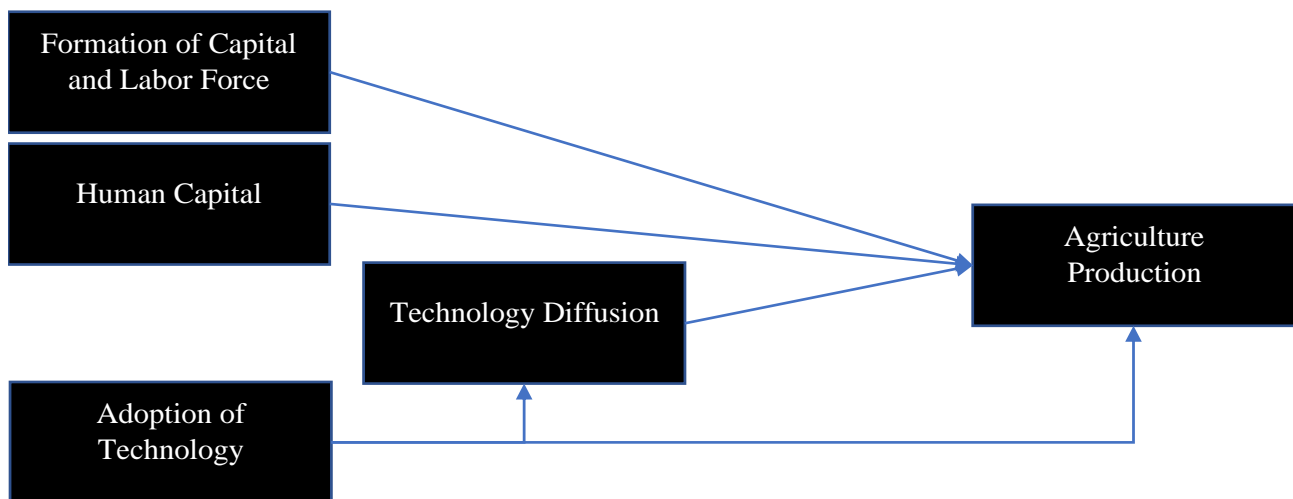


Figure 1. Framework of Study

### 3. METHODOLOGY

#### 3.1 Measurements

The questionnaire for this study was developed using measuring items adapted from previous research. The sample for this study was collected using a five-point Likert scale questionnaire based on the items considered. Aubert et al. (2012) modified the elements for technology adoption. Aubert et al. (2012) modified the scale items for technological dissemination in a second step. Finally, Bontis et al. (2000) modified the human capital scale items. In addition, Singh et al. (2013) altered the scale items for agricultural productivity. Singh et al. (2013) modified the scale items to create capital and labor force. For the face validity of the surveys, these items were carefully revised and verified by research specialists. The questionnaire for this study was finalized after receiving

positive replies from the experts.

#### 3.2 Data Collection

Participants in this study were farmers from Iraq. The small and medium-sized farmers in the agriculture industry were approached to collect data. It was determined whether they understood the questions. They were told of the goal of this study, which made data collection easier for the researcher. In this study, cross-sectional data are collected using a random sample technique.

Furthermore, because this study is based on agricultural output, farmers were the ideal participants. In contrast, the sample size of this study is 404, which is sufficient to generalize the study's conclusions. The responders were rewarded for their participation in the data collection questionnaire.

## 4. RESULTS

### 4.1 Measurement Model

Smart PLS 3.0 was utilized to analyze the collected data for this investigation. The measurement model is used to assess reliability and validity, whereas the structural model is employed to determine the influence of independent variables on dependent variables. This study determines the outcomes using Cronbach's alpha, composite reliability

(CR), factor loadings, and average variance extracted (AVE). AVE is supposed to be 0.50 while CR is 0.70. (F. Hair Jr et al., 2014). Likewise, the optimal factor loading value is 0.60 (Henseler et al., 2010). However, the ideal Cronbach's alpha value for reliability is 0.70. (Fornell et al., 1981). The outcomes of this measuring approach demonstrated the dependability and validity of the investigated items. Figure 2 and Table 1 describe the measuring model's outcomes.

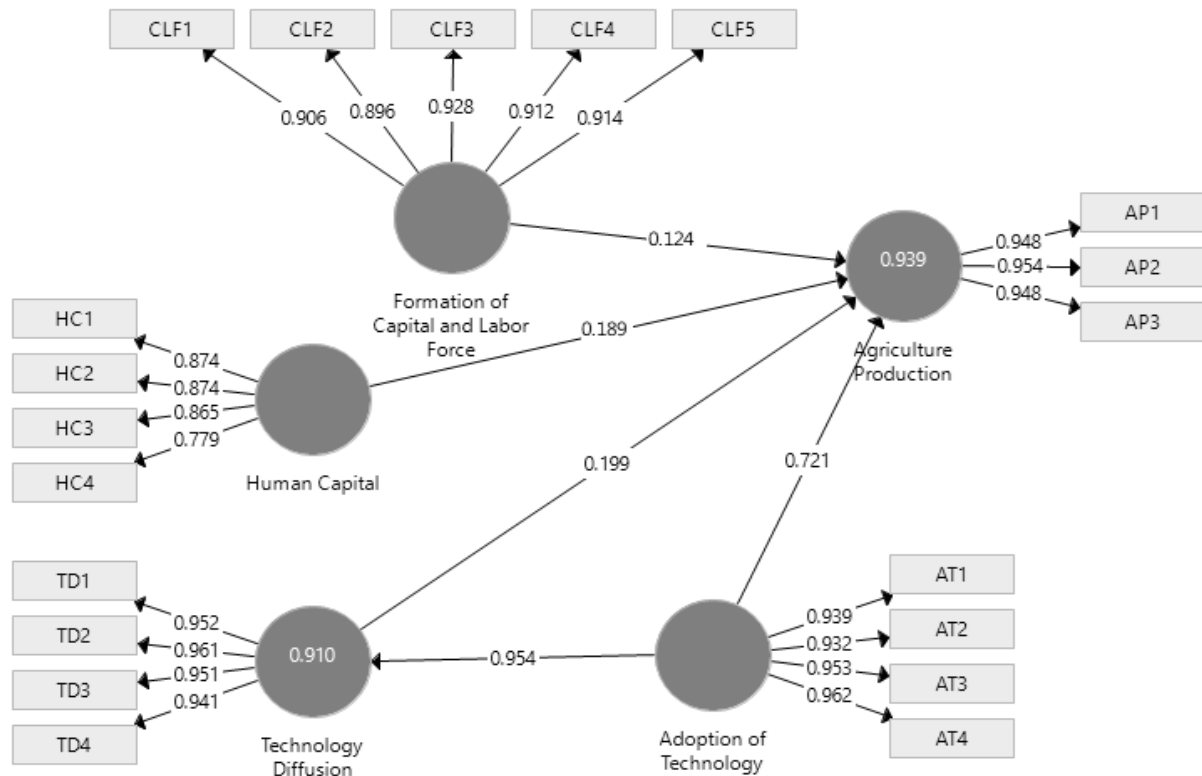


Figure 1. Measurement Model

Table 1. Measurement Model Results – Validity and Reliability

Constructs	Items	Loadings	Cronbach's Alpha	rho_A	CR	AVE
Agriculture Production	AP1	0.948	0.946	0.946	0.965	0.902
	AP2	0.954				
	AP3	0.948				
Adoption of Technology	AT1	0.939	0.961	0.961	0.972	0.896
	AT2	0.932				
	AT3	0.953				
	AT4	0.962				
Formation of Capital and Labor Force	CLF1	0.906	0.949	0.952	0.961	0.831
	CLF2	0.896				
	CLF3	0.928				
	CLF4	0.912				
	CLF5	0.914				
Human Capital	HC1	0.874	0.876	0.913	0.911	0.721
	HC2	0.874				
	HC3	0.865				
	HC4	0.779				
Technology Diffusion	TD1	0.952	0.965	0.965	0.974	0.905
	TD2	0.961				
	TD3	0.951				
	TD4	0.941				

In addition to determining the value of discriminant validity in this measurement model test, this study also determined the value of discriminant validity. The discriminant validity is examined to examine the distinction between scale items utilized for any study construct. Checking the discriminant

validity, this study utilized the Heteritrait-Monotrait (HTMT) approach offered in the measuring model. Gold et al. (2001) suggested that the discriminant validity values for the HTMT approach should not exceed 0.90. The results of the HTMT approach presented in Table 2 indicate the discriminant validity of any study's measuring items.

Table 2. HTMT

	Adoption of Technology	Agriculture Production	Formation of Capital and Labor Force	Human Capital	Technology Diffusion
Adoption of Technology					
Agriculture Production	0.713				
Formation of Capital and Labor Force	0.588	0.607			
Human Capital	0.772	0.791	0.696		
Technology Diffusion	0.791	0.786	0.604	0.782	

### 4.2 Structural Model

The findings of the structural model are used in this study to determine the findings of the hypotheses. The available results determined by structural model path coefficient and indirect effects revealed that all the study hypotheses are significant (see Table 3). Hypothesis 1 results revealed the impact of the formation of labor and capital is significant on agriculture production ( $t = 3.263$ ) and ( $p = 0.001$ ). Hypothesis 2 results revealed the impact of human capital is significant on agriculture production ( $t = 3.857$ ) and ( $p = 0$ ). Hypothesis 3 results revealed that technology adoption is

significant in agriculture production ( $t = 11.410$ ) and ( $p = 0$ ). Hypothesis 4 results revealed that the impact of technology adoption is significant on technology diffusion ( $t = 153.691$ ) and ( $p = 0$ ). Hypothesis 5 results revealed the impact of technology diffusion is significant on agriculture production ( $t = 3.015$ ) and ( $p = 0.003$ ). Lastly, hypothesis 6 results revealed the mediating impact of technology diffusion is significant between the adoption of technology and agriculture production ( $t = 3.002$ ) and ( $p = 0.003$ ). The description of these results is also presented in Figure 3.

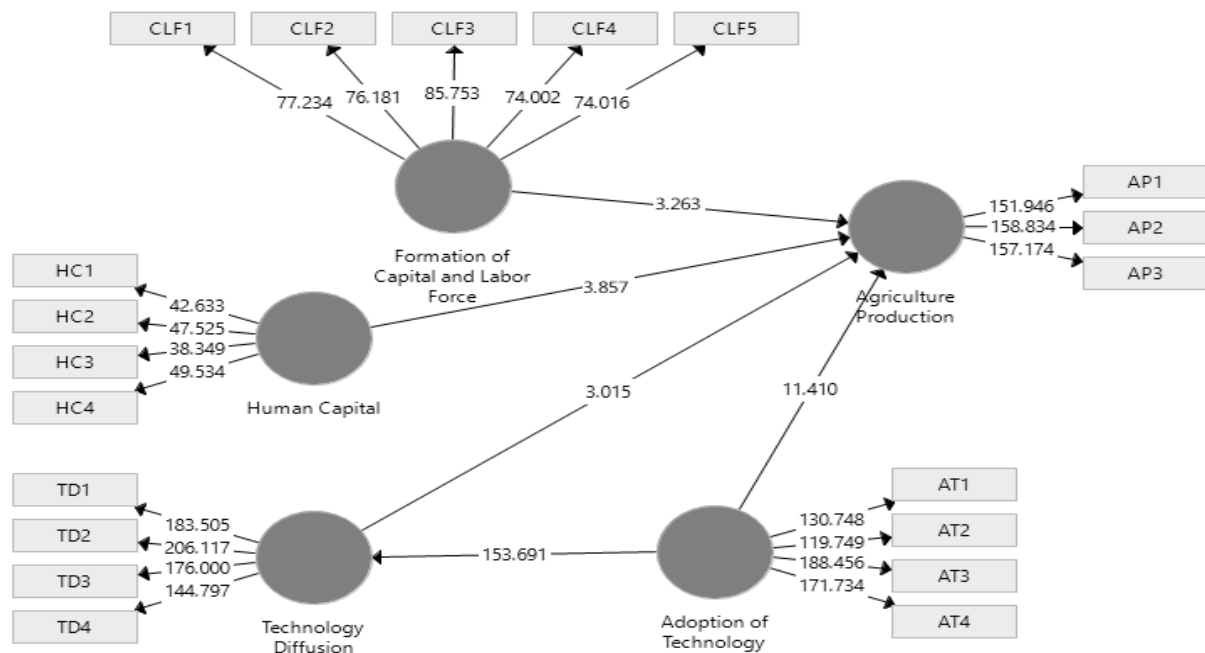


Figure 3. Structural Model

Table 3. Direct and Indirect Impacts

No	Hypotheses	Original Sample	STDEV	T	P
1	Formation of Capital and Labor Force -> Agriculture Production	0.124	0.038	3.263	0.001
2	Human Capital -> Agriculture Production	0.189	0.049	3.857	0.000
3	Adoption of Technology -> Agriculture Production	0.721	0.063	11.410	0.000
4	Adoption of Technology -> Technology Diffusion	0.954	0.006	153.691	0.000
5	Technology Diffusion -> Agriculture Production	0.199	0.066	3.015	0.003
6	Adoption of Technology -> Technology Diffusion -> Agriculture Production	0.190	0.063	3.002	0.003



## 5. DISCUSSION AND CONCLUSIONS

This research is undertaken to increase the Iraqi economy by enhancing agricultural production. The findings of this study indicate that the hypotheses of this investigation are noteworthy. The relationship between capital formation and the labor force is significant in agriculture production. These conclusions are comparable to those of past research describing the significance of the agriculture sector to economic expansion (Olney et al., 2015). Stephens et al. (2018) showed that the development of agriculture is essential for the economic development of every nation. Molina-Maturano et al. (2020) highlighted the importance of human labor skills in enhancing agricultural output. Uduji et al. (2021) also stated that agricultural production is reliable, provided the government develops sustainable policies for farmers. Chrismanto et al. (2019) argued that technical progress is essential for the development of the agriculture industry. The result of hypothesis one is, therefore, valid. Significant ties exist between human capital and agricultural production. These conclusions are identical to those of prior research highlighting the significance of the agriculture sector to economic sustainability (Aacharya et al., 2020; Kant et al., 2022). Xu et al. (2021) determined that developing agricultural labor skills is crucial for the economic success of any nation. Zilli et al. (2020) underlined the relevance of human capital in enhancing the sustainability of agricultural output. Chrismanto et al. (2019) concluded that agricultural innovation is reliable if the government works to build sustainable policies for farmers. With the importance of human capital, Andrei et al. (2020) assert that industrial development is crucial for the success of the agriculture industry. Therefore, the conclusion of hypothesis two is valid.

Furthermore, the relationship between technology adoption and agricultural production is substantial. These results are consistent with the findings of prior research explicating the significance of technology in the agricultural expansion (Stephens et al., 2018). Aubert et al. (2012) demonstrated that the new technology is crucial for Indonesia's agricultural development and economic growth. Kant et al. (2022) underlined the impact of contemporary technology in enhancing Canadian agricultural production. da Silveira et al. (2021) established that contemporary technology in the agriculture sector is dependable, provided the government develops sustainable policies to assist the farmers with technology. According to Jung et al. (2021), technological adoption is required for success in the agriculture industry. The result of the third hypothesis is therefore valid. Similar to the findings of the third hypothesis, the fourth hypothesis concluded that the relationship between technology adoption and technology diffusion is substantial. These findings are comparable to those of prior studies that elucidated the significance of technology for adolescents (Singh et al., 2013). Kant et al. (2022) concluded that farmers must improve their proficiency

with this new technology to increase productivity gains. Aubert et al. (2012) asserted that the significance of current technologies in training agricultural production founders is crucial. Stephens et al. (2018) conclude that modern agriculture technology is beneficial when farmers adopt an innovation adoption mindset. Jung et al. (2021) stated that technology adoption and diffusion are essential for enhancing agricultural sector growth. The result of the fourth hypothesis is therefore valid.

Similar to the findings of the fourth hypothesis, the fifth hypothesis concluded that the association between technological spread and farm production is significant. Similarly, these results are identical and consistent with prior studies that elucidated the significance of technology diffusion for farm productivity (Olney et al., 2015; Stephens et al., 2018). Uduji et al. (2021) determined that technology diffusion is necessary for agricultural labor. Moreover, Xu et al. (2021) acknowledged that introducing technology to farmers is significant for expanding the agriculture industry. The result of the fifth hypothesis is therefore valid. Intriguingly, the results of the sixth hypothesis indicated that the mediating relationship between the adoption of technology and agricultural production is considerable. These findings are consistent with earlier research (Aubert et al., 2012; Bruun et al., 2017; Kant et al., 2022). Stephens et al. (2018) concluded that the new technology benefits farmers when its dispersion corresponds with the farmer's mentality. In addition, Jung et al. (2021) highlighted the impact of contemporary technology and technology spread in agricultural development.

On the other hand, Aubert et al. (2012) determined that modern technology diffusion is essential for the agriculture industry. Consequently, the conclusion of the sixth hypothesis is valid. This study concludes that the adoption of technology, technological dissemination, human capital, capital formation, and labor force substantially impact the output of agricultural products in Iraq.

## 6. IMPLICATIONS

### 6.1 Theoretical Implications

Substantial study results contributed to a powerful framework in the body of knowledge. Earlier studies examined the economic growth of Iraq in terms of government policies and the viability of working conditions. This study has discovered the association between new variables in Iraqi agricultural production. First, the significance of establishing capital and labor is emphasized in this study of agricultural production. Second, this study highlights the importance of human capital's influence on agricultural productivity for Iraq's sustained economic growth. In the preceding research, this relationship was not addressed directly. Thirdly, this research has highlighted the significance of adopting technology to improve agricultural productivity in Iraq. In addition, this study introduces the substantial impact of technological diffusion, which was overlooked in earlier studies concerning agricultural production. The mediating

relationship between the adoption of technology and agricultural production is also a significant contribution to the body of knowledge made by this research. This study has included new variables into the agricultural production model for Iraq's economic sustainability.

## 6.2 Practical Implications

From the standpoint of practical consequences, this study is equally noteworthy, as it reveals the relationship between various essential parameters for boosting agriculture productivity in Iraq. On the one hand, this study indicated that human capital plays an essential role in agricultural productivity in Iraq and that the government should assist farmers with technological improvement. Technology should be used to improve efficiency in machinery and the manufacturing and distribution of goods. Indeed, the agriculture sector is considered the backbone of any nation's economy; therefore, the Iraqi government should efficiently support agricultural sector performance. In addition, this study underlined that in large-scale farming, the workforce must be trained to utilize technology since a good attitude toward technology is essential for the technical advancement of the nation. Similarly, it is the obligation of the farmers to offer improved health facilities for the laborers to ensure that this human capital functions effectively in the target market to achieve sustainable growth. The Iraqi bureaucracy should follow the sustainable economic and agricultural production model of developed nations such as Russia, China, Canada, and the United States to grow the Iraqi economy sustainably.

## 7. LIMITATIONS

Prior research on the agriculture industry relied primarily on secondary data from various studies and surveys, whereas this study relies on primary data collected from Iraqi farmers. Intriguingly, this study determined that technology, the diffusion of technology, and human capital can increase agricultural production in Iraq. This study's innovative theoretical and practical ramifications will increase the literature and the practices of agricultural practitioners in Pakistan. Nevertheless, this study has certain drawbacks. First, the sample for this research was taken from farmers in Baghdad, Iraq. Hence the results cannot be generalized. Second, this study has evaluated the impact of human capital on agricultural production but has not highlighted the need for worker training. Therefore, the future study must establish the significance of worker training as a mediator between human capital and agricultural production. Similarly, our study is confined to the role of technology adoption as a mediator; consequently, future research should examine the role of innovation resistance concerning technology adoption and agricultural production.

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