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-RESEARCH ARTICLE-

PHYSICAL, HUMAN, AND SOCIAL CAPITAL AND ECONOMIC GROWTH AFFECTING THE ADOPTION OF NEW TECHNOLOGY BY PADDY-RICE FARMERS IN THE VIETNAMESE

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—Abstract—

The adoption of technology in the agricultural sector is the most critical factor for the success of the agricultural sector, and recent studies and regulators must focus on this aspect. Consequently, this article investigates the effect of physical capital, such as agricultural land, raw material import, and access to electricity, human capital, social capital, and economic development, on technology adoption in Vietnam's agricultural sector. The secondary source was used to extract data from the World Development Indicators (WDI) database between 1991 and 2021. In addition, the dynamic autoregressive distributed lag (DARDL) method was used to examine the relationship between the variables. The results revealed that agricultural land, raw material import, access to electricity, human capital, social capital, and economic development are positively associated with adopting technology in Vietnam's agricultural sector. The article assists policymakers in formulating technological adoption policies in the agricultural sector by promoting adequate physical, social, and human capital and robust economic growth.

Keywords: Physical capital, agricultural land, agricultural raw material import, access to electricity, human capital, social capital, economic growth, technology adoption

1. INTRODUCTION

The world has witnessed several significant natural changes over the past few decades. These modifications in context are related to technology. Humanity is exerting its utmost efforts to guarantee maximum technological advancement to provide humankind with convenience. Every aspect of society is dependent on technology. Adopting modern technology is among the most notable distinctions between developing and developed economies. The competition severely crushed countries that failed to implement technology from the modern era. There are a variety of industries and sectors in every nation. These sectors are essential, but some, such as agriculture, are more significant because they are associated with life's necessities. Agriculture relies on natural resources such as water, oxygen, and land (Hoang et al., 2020). Those nations that provide exceptional support for their agriculture sectors have attained developed nation status. The global demand for sustenance is increasing as time passes. One of the reasons for its growth is the rise in population. Such a rise in food demand intensifies the burden on the agriculture industry to meet the demand. (Basso et al., 2020) The world's agriculture sector is also utilizing various strategies to increase its production capacity. Adopting technology from the modern era is one of the crucial factors that plays a vital role in enhancing agricultural production capacity. Agriculture's incorporation of current technology results in 1) rapid product growth, 2) an increase in production capacity, 3) cost-effectiveness, 4) dependability, and 5) a reduction in environmental degradation (Harwood, 2020). Considering the significance of technology to the agriculture industry, this study sought to investigate it.

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Vietnam's diverse landscape includes mountains, rich deltas, and dense forests. Each has different micrometric conditions in addition to soil properties. Such a wide variety of habitats fosters an equally wide variety of production techniques and agroecological regions. Agriculture occupies 35 percent of the country's total land area, or 10.2 million hectares (H.-D. Nguyen et al., 2019). Vietnam has eleven central agricultural production systems: rice, maize, coffee, shrimp, cassava, cashews, tea, pepper, oranges, and pig. Smallholder cultivators currently produce 71% of the food consumed in Vietnam (N. Nguyen et al., 2021). Vietnam believes in agriculture development because they recognize that it is one of the industries that can positively impact the country's economy. Despite this, the country faces several obstacles, including 1) low productivity, 2) a lack of technology, 3) a lack of agricultural education, and 4) a lack of agricultural importance awareness (Duong et al., 2022; N. Nguyen et al., 2021). Adopting technology from the modern era is the most crucial of all. Technology is one of the factors contributing to the resolution of several issues facing the agriculture industry today. Figure 1 illustrates the agriculture sector's GDP.

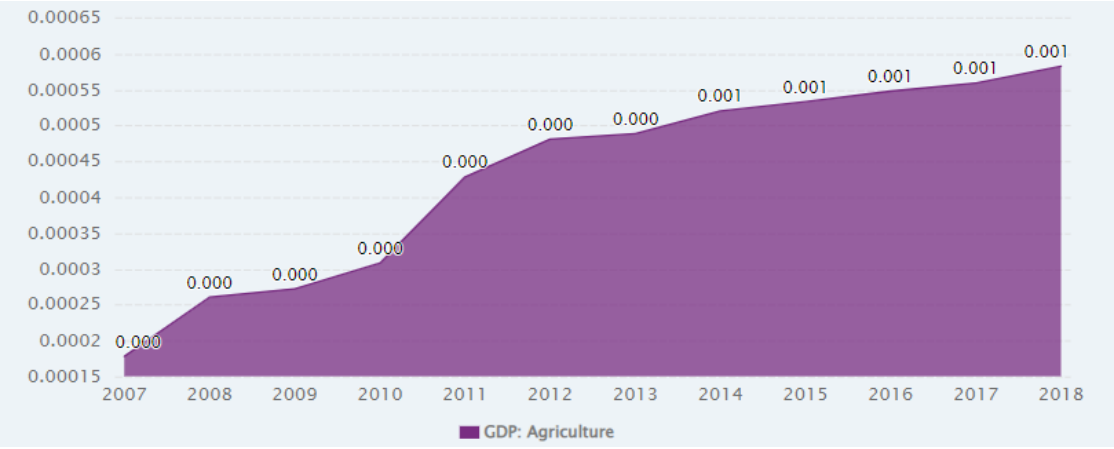

Figure 1. GDP from Agriculture in Vietnam

There is a great deal of literature on technology adoption in the context of agriculture in Vietnam; however, there are several gaps in the literature that the present investigation seeks to fill. These gaps include: 1) even though technology adoption in the agricultural context has been studied extensively from different perspectives, at different times, and in different economies, it has not yet reached its zenith as there are numerous of its aspects that have yet to be explored; and 2) even though technology adoption in the agricultural context has been 2) In recent years, the equation based on factors such as technology adoption, agricultural land, agricultural raw material import, access to electricity, human capital index, economic growth (EG), and social capital has not been verified in Vietnam. 3) Ullah et al. (2020) and Utami et al. (2019) investigated whether there is a relationship between agricultural land and technology adoption in the context of agriculture; however, the current study will also examine this relationship, along with

other variables such as agricultural raw material import, access to electricity, human capital index, EG, and social capital using a new sample set. 4) Bakari (2018) and Jongwanich et al. (2022) investigated whether there is a relationship between agricultural raw material imports and technology adoption in the context of agriculture. However, the current study will also examine this issue, along with other variables such as agricultural land, access to electricity, human capital index, EG, and social capital, with a new sample set focusing on Vietnam. 5) Shallo et al. (2020) and Gebreegziabher et al. (2012) investigated whether there is a relationship between access to electricity and technology adoption in the context of agriculture; however, the current study will also examine this issue alongside other variables such as agricultural land, agricultural raw material import, human capital index, EG, and social capital in Vietnam using a new data sample. 6) Danquah et al. (2017) and Salam et al. (2019) investigated whether there is a relationship between the human capital index and technology adoption in the context of agriculture; however, the current study will also investigate this relationship, along with other variables such as agricultural land, agricultural raw material import, access to electricity, EG, and social capital with a new sample set. 7) Husen et al. (2017) and Gao et al. (2019) investigated whether there is a connection between social capital and technology adoption in the context of agriculture; however, the current study will also investigate this issue, along with other variables such as agricultural land, agricultural raw material import, access to electricity, and human capital index in Vietnam using a new sample set. 1) Being one of the most important topics of the modern era, i.e., technology incorporation in the agriculture sector, the present study will emphasize the need to investigate it, particularly in the context of Vietnam; 2) The study's significance is reflected by the following: 2) Although there is a great deal of literature on technology adoption specifically in the agriculture sector, the present study will add to the literature on the subject in the context of Vietnam; 3) The study will provide a guideline as well as assistance to the technology adoption specifically in the agriculture sector-related professionals to review and provide the support for upgrading the policies to enhance the agriculture sector's performance specifically in Vietnam; and 4) The results of the study will be presented in the context of Vietnam.

2. LITERATURE REVIEW

The land is one of nature's many gifts to humanity and one of the most valuable. The land provides numerous benefits to humanity, including water, food, and other objects. Food, one of humanity's fundamental necessities, is produced on agricultural land. Properly using agricultural territory is one of the most significant distinctions between developed and developing nations. With time, the agriculture industry has also witnessed progress. According to the literature, there is a strong correlation between agricultural land and technology adoption. Ullah et al. (2020) examined the relationship between information asymmetry, input market, innovation adoption, and agricultural land use in this context.

The investigation was conducted on a Pakistani population. The research is empirical. As a sample, the study utilized information from 395 respondents. Using questionnaires, the sample information was gathered. For analysis, the investigation utilized MU and MM testing analysis. The analysis shows a significant relationship between information asymmetries, input markets, innovation adoption, and agricultural land use. In addition, Utami et al. (2019) investigated whether agricultural extension services and rural financing play a role in adopting agricultural technology. The investigation was conducted on an Indonesian population. The research is empirical. Thirty years worth of data was utilized for the investigation as a sample. Using questionnaires, the sample information was gathered. The study employed co-integration and regression equation analysis for analysis. According to the analysis outcomes, agricultural extension services and rural financing are crucial to adopting technology in Indonesia's agriculture sector.

Similarly, Curry et al. (2021) investigated whether socio-cultural factors play any role in the agricultural technology adoption process. The population studied consisted of developing economies. The research is empirical. According to the findings, there are additional obstacles to the adoption and innovation of technology besides challenges with education levels, capital, and other financial and technical resources. Transferring technology to farmers can be challenging because suggested innovations and technologies, as well as how they are introduced to and presented to target populations, are frequently incompatible with indigenous values, customs, socio-cultural institutions, and ways of doing things. In addition, Ayenew et al. (2020) examined whether adopting technology in the agriculture sector influences farmer welfare. The investigation was conducted on an Ethiopian population. The research is empirical. The research sampled information from 150 farmers. Using questionnaires, the sample information was gathered. ES regression analysis was utilized for analysis in this study. The results of the analysis indicate that the incorporation of technology in the agriculture sector has a significant impact on farmer welfare, particularly in Ethiopia. Likewise, Suri et al. (2022) worked on agricultural technology in 2022. The research was conducted on an African population. The research included a literature review. Variability increases the difficulty of the adoption process, limits the applicability of several advances, and leads to the stagnation of technology use, according to the findings.

Several factors, such as basic materials, technology adoption, and government support, determine the success or failure of a country's agricultural sector. Some nations import basic materials, while others import machinery because a country cannot meet all of the agricultural sector's requirements. Raw materials are the foundation of any nation's prosperity. Agriculture sector development in the context of technology adoption is significantly correlated with agricultural raw material imports. In this context, Bakari (2018) examined whether there is a correlation between agricultural growth, the importance of agricultural raw materials, and the adoption of technology. The research was conducted on a North African population. The study is empirical. The survey

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sampled information from 51 years. The specified sample data spans the years 1965 through 2016. Co-integration analysis was utilized for research in this study. According to the analysis results, there is a significant relationship between agricultural growth (including the adoption of technology) and the import of agricultural raw materials in North Africa.

Similarly, adopting modern technologies to improve the performance of any industry has become essential. The same holds for the agricultural sector. Abidin, Haseeb, and Islam (2022) examined whether agricultural irrigated land, raw material imports, labor force, and capital formation are related to rice production. The investigation was conducted on a Malaysian population. The research is empirical. The survey sampled information from 39 years. The specified sample data spans the years 1981 through 20120. The study employed the ADF analysis method for purposes of analysis. According to the analysis's findings, irrigated agricultural land, raw material imports, labor force, and capital formation significantly impact rice production, particularly in Malaysia.

Additionally, technology adoption is crucial to the entire procedure. Similarly, Jongwanich et al. (2022) examined the triangular relationship between technological progress, import penetration, and labor markets. The investigation was conducted on a Thai population. The research is empirical. According to the findings, technological development and import penetration substantially impact labor markets, particularly in Thailand. In addition, Ugwu et al. (2012) examined the impact of agricultural reforms on the agriculture industry. The investigation was conducted on a Nigerian population. The research is empirical. The survey sampled information from 49 years. The specified sample data spans the years 1960 through 2019. For analysis, the study utilized regression analysis.

According to the findings of the analysis, agricultural reforms have a significant impact on the Nigerian agricultural sector. In addition, implementing modern technology is a crucial component of agricultural reforms. Agriculture biotechnology is one of the technologies of the modern era. Its implementation has a significant impact on the agricultural sector. In this context, Spielman et al. (2014) worked on seed and agriculture biotechnology. The investigation was conducted on an Indian population. The research is empirical. According to the findings, additional substantial policy changes are required to promote continuous innovation, reduce regulatory uncertainty, and promote firm- and industry-level growth. Additionally, public funding for agricultural research must continue to support technological advancement.

The globe has evolved into a global commune. All aspects of globalization depend on the availability of electricity. Due to globalization, technology is increasingly adopted. Without electricity, technological advancement is impossible. There is a strong correlation between technology adoption and access to electricity. In this context, Shallo

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et al. (2020) investigated the determinants of biogas adoption in the agriculture sector. The investigation was conducted on an Ethiopian population. The research is empirical. As a sample, the research utilized information from 268 households. Using questionnaires, a representative sample of data was collected. The study employed the BL regression model analysis technique for analysis. According to the analysis outcomes, electricity access is one of the most essential factors for technology adoption. In addition, the country should give special attention to electricity access to promote technology adoption.

Similarly, Bhatt et al. (2021) investigated whether there is a correlation between power sector reforms and technology adoption. The investigation was conducted on an Indian population. The research is empirical. To guarantee proper and effective reforms in the Indian electricity distribution sector, the results suggest adopting new technologies is necessary. In addition, Gebreegziabher et al. (2012) investigated the possibility of a correlation between energy transition and technology adoption. The investigation was conducted on an Ethiopian population. The research is empirical. As a sample, the research utilized information from 350 urban households. Using questionnaires, a representative sample of data was collected. For analysis, the study used regression analysis. The analysis results indicated that the energy transition is one of the most essential prerequisites for technology adoption. Energy access is one of the primary focuses of energy transition. Without energy access, the likelihood of successful technology adoption is diminished.

In addition, Bhatt et al. (2020) investigated the role of stakeholders in adopting technology, specifically in the electricity industry. The investigation was conducted on an Indian population. The research is empirical. Loss reduction and LRT adoption policies may be effectively implemented by engaging customers through information exchange and highlighting the benefits of LRT projects, particularly those that improve the quality of the energy supply. Similarly, Akinwale et al. (2015) investigated the connection between renewable energy technologies and the reduction of electricity poverty and the impact of technology adoption on this connection. The investigation was conducted on a Nigerian population. The research is empirical. The study sampled data from 143 respondents. Using questionnaires, a representative sample of data was collected. For analysis purposes, the investigation employed the AD analysis method. According to the analysis's findings, the adoption of renewable energy technologies has a significant impact on reducing electricity poverty.

The ultimate goal of technological advancements is to facilitate human activity. Due to climate change, the land, particularly agriculture, alters its behavior over time. To get the most out of the land, the world is employing technologies from the modern era. The ultimate goal is human support. According to the literature, there is a substantial relationship between human capital and agricultural technology adoption. Danquah et al. (2017) examined the relationship between human capital, innovation, and technology

adoption in this context. The investigation was conducted on a population of Saharan African economies. The research is empirical. The analysis sampled information from the past 50 years. The specified sample data span the years 1960 through 2010. For analysis, the study utilized panel data analysis. According to the analysis's findings, a significant relationship exists between human capital, innovation, and technology adoption.

Moreover, human capital is the central component of the entire nexus. Similarly, Salam et al. (2019) investigated whether a relationship exists between technology adoption, innovation, human capital, and the economy. A population of Lower-Middle-Income economies served as the subject of the study. The research is empirical. The survey sampled information from 16 years. The specified sample data spans the years 2000 through 2016. For analysis, the study employed the GMM method. According to the analysis's findings, a significant relationship exists between technology adoption, innovation, human capital, and the economy. In addition, Abidin, Haseeb, Islam, et al. (2022) examined whether a correlation exists between technology adoption, labor force, and human capital formation. The investigation was conducted on a Malaysian population. The research is empirical. The survey sampled information from 39 years. The specified sample data spans the years 1991 through 2020. The study employed the ADF analysis method for purposes of analysis. According to the analysis's findings, there is a significant relationship between technology adoption, labor force, and human capital formation. In addition, Abdurakhmanova et al. (2021) investigated whether a correlation exists between human capital, economic development, and technology adoption. The investigation was conducted on the economies of 175 countries. The research is empirical.

The survey sampled information from a single year. The period covered by the sampled data is January to December 2015. The study employed the ARDL analysis method for analysis. According to the analysis results, a significant relationship exists between human capital, economic development, and technology adoption. In addition, Skare et al. (2022) investigated the possibility of a relationship between human capital and technology adoption. The investigation was conducted on the economies of 104 countries. The research is empirical. The analysis sampled forty years of data. The specified sample data spans the years 1970 through 2010. For purposes of analysis, the investigation utilized the HCCTA analysis method. According to the analysis's findings, there is a significant relationship between human capital and technology adoption.

Social capital is one of the most critical factors of the modern era, as it influences every aspect of society. Similarly, a strong correlation exists between social capital and technology adoption. In this context, Husen et al. (2017) investigated whether there is a correlation between social capital and agricultural technology adoption. The investigation was conducted on an Ethiopian population. The research is empirical. The sample for the research consisted of data from 398 farmers. Using questionnaires, a

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representative sample of data was collected. The probit analysis paradigm was utilized for analysis in this study. In the context of agriculture, the research suggested that there is a significant relationship between social capital and technology adoption.

Similarly, Lee (2015) examined whether there is a relationship between social capital and technology adoption in tourism. The investigation was conducted on an American population. The research is empirical. As a sample, the research utilized information from 1166 respondents. Using questionnaires, a representative sample of data was collected. The study employed multiple regression analysis for analysis. The research suggested a significant relationship between social capital and technology adoption in tourism.

In addition, Gao et al. (2019) examined the possibility of a relationship between EG, land tenure, and technology adoption. The investigation was conducted on a Chinese population. The research is empirical. As a sample, the research utilized information from 443 farmer families. Using questionnaires, a representative sample of data was collected. For purposes of analysis, the study used the alternating probit model. According to the analysis's findings, there is a significant relationship between environmental governance, land tenure, and technology adoption. In addition, Tsai et al. (2021) investigated whether there is a correlation between EG and technology adoption in the context of climate change. The investigation was conducted on a Kenyan population. The research is empirical.

The research sampled data from 122 farmers. Using questionnaires, a representative sample of data was collected. For analysis, the study utilized regression analysis. According to the analysis's findings, there is a significant relationship between EG and technological adoption in the context of climate change. In addition, Birir (2021) investigated whether there is a relationship between EG regarding identity and technology adoption. The investigation was conducted on a Taiwanese population. The research is empirical. The study sampled data from 81 respondents. Using questionnaires, a representative sample of data was collected. For purposes of analysis, the investigation utilized the HCCTA analysis method. According to the analysis's findings, there is a significant correlation between EG in terms of identity and technology adoption.

3. RESEARCH METHODS

This article examines the influence of agricultural land, raw material import, access to electricity, human capital, social capital, and economic development on adopting technology in the Vietnamese agricultural sector. The secondary source was used to extract data from the WDI database from 1991 to 2021. The researchers developed the following study equation:

$$TAD_t = \alpha_0 + \beta_1 AGL_t + \beta_2 ARMI_t + \beta_3 AE_{it} + \beta_4 HCI_t + \beta_5 SC_t + \beta_6 EG_t + e_t \quad \textbf{(1)}$$

Where;

TAD	=	Technology Adoption
t	=	Period
AGL	=	Agricultural Land
ARMI	=	Agricultural Raw Materials Import
AE	=	Access to Electricity
HCI	=	Human Capital Index
SC	=	Social Capital
EG	=	Economic Growth

The primary variable of the study was technology adoption, with high-technology exports (as a percentage of manufactured exports) serving as a proxy. In addition, four predictors are used, including physical capital proxies such as agricultural land (percentage of land area), Agricultural raw material imports (percentage of goods import), and access to electricity, rural (percentage of rural population), human capital proxies such as human capital index, social capital proxies such as social contribution (percentage of revenue), and economic growth proxies such as GDP growth (percentage of annual growth). Table 1 contains these proxies.

Table 1. Variables with Measurements

S#	Variables	Measurement	Sources
01	Technology Adoption	High-technology exports (% of manufactured exports)	WDI
02	Physical Capital	Agricultural land (% of land area)	WDI
		Agricultural raw material imports (% of goods import)	WDI
		Access to electricity in rural (% of rural population)	WDI
03	Human Capital	Human capital index	WDI
04	Social Capital	Social contribution (% of revenue)	WDI
05	Economic Growth	GDP growth (annual percentage)	WDI

Using descriptive statistics, the study examines the variable particulars. In addition, the correlation matrix is used to explore the correlation between variables. In addition, the unit root between variables is reviewed using the Phillips-Perron (PP) and augmentedDickey–Fuller (ADF) tests. The research equation is as follows:

$$d(Y_t) = \alpha_0 + \beta t + \gamma Y_{t-1} + d(Y_t(-1)) + \varepsilon_t \quad \textbf{(2)}$$

Moreover, the research also checks the co-integration using the (Westerlund et al., 2008) approach. The equation is given as under:

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$$LM_{\varphi}(i) = T\hat{\varphi}_i\ (\hat{r}_i/\hat{\sigma}_i) \quad \textbf{(3)}$$

$$LM_{\tau}(i) = \hat{\varphi}_i/SE(\hat{\varphi}_i) \quad \textbf{(4)}$$

In the equations mentioned above, $\hat{\boldsymbol{\varphi}}_{\boldsymbol{i}}$, shows the estimate beside standard error, while $r^{2}{}_{i}$ shows the long-run measured variance, $\boldsymbol{\varphi i}\ \boldsymbol{(L)} = \mathbf{1} - \sum \boldsymbol{\varphi_{ij}L^{j}}$ shows the scalar polynomial with L lag length, and ρ_i shows the factor loading parameters vector.

In addition, the ARDL model is utilized to examine the association between the variables. It is the optimal strategy when some variables are stationary at the level and others at the first difference (Nazir et al., 2018). In addition, the ARDL model can control the heteroscedasticity and autocorrelation that influence estimations (Zaidi et al., 2018). The equation is given as follows:

$$\Delta TAD_t = \alpha_0 + \sum\delta_1\Delta TAD_{t-1} + \sum\delta_2\Delta AGL_{t-1} + \sum\delta_3\Delta ARMI_{t-1} + \sum\delta_4\Delta AE_{t-1} + \sum\delta_5\Delta HCI_{t-1} + \sum\delta_6\Delta SC_{t-1} + \sum\delta_7\Delta EG_{t-1} + \varphi_1 TAD_{t-1} + \varphi_2 AGL_{t-1} + \varphi_3 ARMI_{t-1} + \varphi_4 AE_{t-1} + \varphi_5 HCI_{t-1} + \varphi_6 SC_{t-1} + \varphi_7 EG_{t-1} + \varepsilon_t \quad \textbf{(5)}$$

The research also applied the DARDL approach to check the nexus among the variables. This approach was developed by Jordan et al. (2018) and can cover all the issues not covered by the ordinary ARDL approach. The equation is mentioned below:

$$\Delta TAD_t = \alpha_0 + \sum\delta_1\Delta TAD_{t-1} + \sum\delta_2\Delta AGL_t + \sum\delta_3\Delta AGL_{t-1} + \sum\delta_4\Delta ARMI_t + \sum\delta_5\Delta AGRI_{t-1} + \sum\delta_6\Delta AE_t + \sum\delta_7\Delta AE_{t-1} + \sum\delta_8\Delta HCI_t + \sum\delta_9\Delta HCI_{t-1} + \sum\delta_{10}\Delta SC_t + \sum\delta_{11}\Delta SC_{t-1} + \sum\delta_{12}\Delta EG_t + \sum\delta_{13}\Delta EG_{t-1} + \varepsilon_t \quad \textbf{(6)}$$

Research Findings

Using descriptive statistics, the study examines the variable particulars. The results indicated that the mean value of TAD was 18.500 percent, the mean value of AGL was 31.196 percent, and the mean value of ARMI was 2.906%. In addition, the results revealed that the mean value of AE was 88.748 percent, HCI was 0.646%, SC was 0.666%, and EG was 6.669%. Table 2 contains these values.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
TAD	31	18.500	14.451	7.668	50.662
AGL	31	31.196	6.256	20.741	40.635
ARMI	31	2.906	0.631	1.490	3.879
AE	31	88.748	10.843	67.597	100.000
HCI	31	0.646	0.030	0.598	0.708
SC	31	0.666	0.118	0.474	0.861
EG	31	6.669	1.564	2.562	9.540

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In addition, the correlation matrix is used to examine the correlation between variables. The results revealed that agricultural land, raw material import, access to electricity, human capital, social capital, and economic development are positively associated with adopting technology in Vietnam's agricultural sector. Table 3 contains these values.

Table 3. Matrix of Correlations

Variables	TAD	AGL	ARMI	AE	HCI	SC	EG
TAD	1.000						
AGL	0.811	1.000					
ARMI	0.182	0.635	1.000				
AE	0.717	0.962	0.752	1.000			
HCI	0.865	0.964	0.517	0.924	1.000		
SC	0.869	0.982	0.560	0.952	0.986	1.000	
EG	0.444	-0.519	-0.264	-0.513	-0.515	-0.534	1.000

Moreover, PP and ADF tests determine the unit root between variables. TAD, AGL, ARMI, SC, and EG were stationary at I(0), while AE and HCI were stationary at I(1). Table 4 contains these values.

Table 4. Unit Root Test

	ADF		PP	
Series	Level	First difference	Level	First difference
TAD	-2.674***	------	-2.192***	------
AGL	-3.019***	------	-2.033***	------
ARMI	-2.982***	-----	-3.664***	------
AE	------	-4.320***	------	-4.774***
HCI	------	-4.309***	------	-4.342***
SC	-3.177***	------	-2.772***	------
EG	-3.129***	------	-3.111***	------

In addition, co-integration is examined using the (Westerlund et al., 2008) method. Results showed that p-values are less than 0.05 and t-values are more significant than 1.96. These results demonstrated the existence of co-integration, as shown in Table 5.

Table 5. Co-integration test

Model	No Shift		Mean Shift		Regime Shift	
	Test Stat	p-value	Test Stat	p-value	Test Stat	p-value
LM_{τ}	-4.302	0.000	-5.387	0.000	-6.504	0.000
LM_{φ}	-4.338	0.000	-5.678	0.000	-6.566	0.000

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The research also utilized the DARDL method to examine the relationship between the variables. The results revealed that agricultural land, raw material import, access to electricity, human capital, social capital, and economic development are positively associated with adopting technology in Vietnam's agricultural sector. These results are shown in Table 6.

Table 6. Dynamic ARDL Model

Variable	Coefficient	t-Statistic	Prob.
TAD	-2.303***	-4.372	0.000
AGL_{t-1}	0.392***	5.403	0.000
AGL	0.875**	2.837	0.016
$ARMI_{t-1}$	1.201**	2.764	0.021
ARMI	2.109***	5.764	0.000
AE_{t-1}	0.473***	5.493	0.000
AE	1.201***	4.453	0.000
HCI_{t-1}	0.498**	2.432	0.032
HCI	0.483**	2.654	0.023
SC_{t-1}	2.101***	5.378	0.000
SC	1.292***	4.393	0.000
EG_{t-1}	1.209***	5.439	0.000
EG	0.493***	5.493	0.000
Cons	0.883***	4.673	0.000

R square = 60.453 Stimulation = 5000

4. DISCUSSIONS

Adopting technology has significantly contributed to the growth and improvement of agricultural productivity. In prior research, Kumar et al. (2018) supported this hypothesis. According to them, the impact of agricultural land on technological adoption can be crucial. The quality and availability of land can increase farmers' profitability and output, influencing their capacity and propensity to adopt innovative and new technologies. Farmers with access to sufficient resources and fertile land will be more interested in implementing and investing in technologies that improve their efficiency and increase their yields. In such a case, they earn a more significant profit from their products, which enables them to gain knowledge of and access to technologies that would otherwise be challenging to implement. However, if the land is of poor quality, they will struggle to generate a profit and may be unwilling to implement any technologies. In addition, certain crops require technology such as big data, machine learning, IoT, and many others, as well as specialized apparatus.

Consequently, the incorporation of technology in agricultural land has a significant bearing on the profitability of the business. In summary, agricultural land has a

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considerable impact, as farmers with greater profits are more likely to implement advanced technology on their land. Access to resources and high-quality land will increase farmers' likelihood of implementing new technologies.

Importing agricultural materials such as pesticides, seedlings, and fertilizers can increase land productivity, resulting in effective land utilization. Additionally, Amelework et al. (2021) supported this hypothesis. This import also gives producers access to plants and seed materials that enable crop cultivation, thereby diversifying the agricultural sector. Importing raw materials for agricultural purposes can provide opportunities for implementing new technologies and techniques that may not be readily available in the country, promoting technology adoption. This hypothesis was also supported by a study by Gorlov et al. (2020). They analyzed the outcome using the methods of trend analysis, graphical representation of data, financial analysis, and statistical data analysis. If a country lacks the resources or raw materials to produce certain livestock or crops, importing these resources will allow it to implement more productive technologies and agricultural practices, according to them. Without technology, it would be difficult for a business to generate more revenue in the modern era. Importing raw materials will allow farmers to produce products that may not be available locally, thereby increasing their profitability and promoting the adoption of new technologies. Innovative technologies provide numerous benefits contingent upon their application in the agricultural industry.

Access to electricity influences technology adoption in agricultural land positively. Farmers with access to electricity can use innovative and new equipment, such as threshers and pumps, which reduce the labor required, increase productivity, and aid in land management. Pascaris et al. (2021) also supported this hypothesis in a previous study. To analyze the data, a semi-structured interview was conducted. The electricity facility also enables farmers to utilize various agricultural techniques, such as remote sensing, data analytics, and GPS mapping, which provide farmers with a better understanding of crop yield, soil health, and weather patterns, aiding decision-making and boosting productivity. In addition, Elahi, Khalid, and Zhang's study from 2022 supported this hypothesis. According to them, having access to technology also facilitates communication and collaboration between farmers and specialists, allowing them to share knowledge about current practices, cutting-edge technologies, and innovative techniques that boost productivity. This facility will provide farmers with the most up-to-date technologies and a platform to help them implement new technologies and equipment.

The human capital index measures the labor force's education, health, and competence levels. A high human capital index will positively affect the adoption of technology. Che et al. (2018) also supported this hypothesis with their research. According to them, increasing the capital index will enable agricultural employees and farmers to learn and comprehend new techniques, practices, and technologies, allowing them to effectively implement new and innovative technologies to boost efficiency and productivity. More

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skilled and educated workers will be more receptive to adopting new solutions or technologies to advance agriculture's current procedures. A greater capital index will increase collaboration and communication in the agricultural sector, disseminating innovative technology practices and knowledge. Farmers with a high level of education and expertise will make better decisions based on real-world data, leading to a rise in productivity. In conclusion, a higher human capital index will positively affect technology adoption, allowing farmers to learn and comprehend technologies and develop innovative solutions to extant problems.

Social impact provides the means to increase producers' knowledge and awareness of the potential and benefits of innovative agricultural technologies, thereby enhancing agricultural land productivity. Social impact also provides opportunities to expand networking and collaboration among farmers or specialists, disseminating new techniques and innovative agricultural technologies. This hypothesis was also supported by Adnan et al. (2019). According to them, the social contribution also enables farmers to access resources such as information, markets, and financing that assist them in effectively implementing this technology for agricultural purposes. Consequently, the social contribution increases the adoption of innovative new agricultural technologies and techniques. This increase in social assistance also results in a rise in economic output for the agricultural sector, as innovative technologies increase productivity, resulting in high profits and income for farmers. In conclusion, the communal contribution will positively affect the agricultural sector.

An increase in the country's economy leads to more significant investments in infrastructure and the adoption of new technologies, which modernize the agricultural sector and increase its efficacy and productivity. Pawlak et al. (2020)'s previous study also supported this hypothesis. According to them, increased GDP through increased investment can contribute to a rise in agricultural technology adoption. Producers can utilize drones, GPS mapping, the Internet of Things (IoT), and sensors to increase farm productivity as the nation's economy improves. Farmers will have greater access to funds, loans, and other financing options, allowing them to invest in the technological utilization of agricultural land as the GDP rises. In brief, the positive effect of GDP growth on technology adoption is significant, increasing land productivity and efficiency.

5. IMPLICATIONS

This paper makes a substantial contribution to the body of knowledge. This document provides insights into the significance of agricultural technology adoption. Vietnam's agricultural sector contributes significantly to the country's economy. This sector is not only contributing to the growth of the country's gross domestic product, but it is also a significant source of employment. However, this sector still faces obstacles that can be surmounted by various factors, such as agricultural land, agricultural raw material

import, access to electricity, the human capital index, and social capital, and their influence on the adoption of technology. This paper provides policymakers, government, and non-government agencies with strategies for increasing the adoption of digital technologies in the agricultural territory. These technologies increase not only agricultural land's productivity but also its efficacy. The article assists policymakers in formulating technological adoption policies in the agricultural sector by promoting adequate physical, social, and human capital and robust economic growth. The Vietnamese government should take measures to implement these strategies so that farmers can implement these technologies, as it is impossible to increase profitability without technological tools.

6. LIMITATIONS

The limitations of this paper can be transcended in the future. This paper analyzes the impact of agricultural land, agricultural raw material import, access to electricity, the human capital index, and social capital on technology adoption. Training programs and government funding can be used to study the positive effects of technology adoption for future reference. In addition, this paper provides insight into Vietnam, a developing nation, and this study may not apply to developed countries. Therefore, sophisticated nations can be used in the future to examine the effect of these factors on technological adoption.

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