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Article

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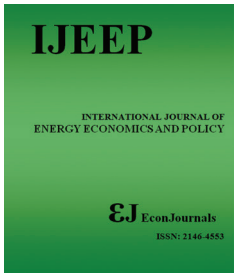

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The Role of Renewable and Nonrenewable Energy on Agricultural Economics in Indonesia

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ABSTRACT

Recently, the prominent involvement of energy in the agriculture sector significantly influences agriculture economics and needs researchers' focus. Hence, the current article examines the impact of renewable energy production (REP) and renewable energy consumption (REC), fossil fuel energy consumption (FFEC) and energy import and use on the agriculture economics in Indonesia using data from 1986 to 2020. The current research has used the Augmented Dickey-Fuller test for checking the unit root and autoregressive distributed lag to test the nexus among constructs. The results revealed that REP and REC, FFEC and energy import and use have a positive association with agriculture economics in Indonesia. This study provides guidelines to the policymakers while developing regulations related to the improvement of agriculture economics.

Keywords: Renewable Energy Production, Energy Use, Fossil Fuel Energy Consumption, Energy Import, Agriculture Economics
JEL Classifications: O13, Q13, Q29, Q43, P181.

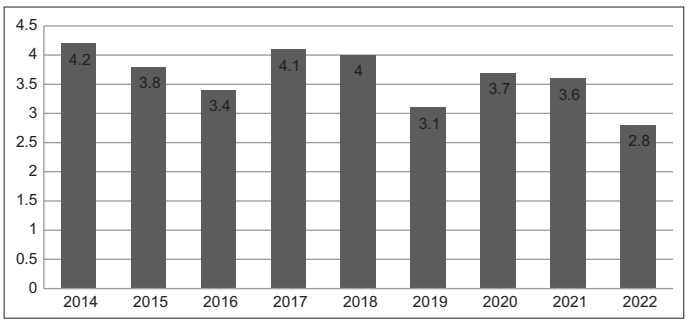
1. INTRODUCTION

The Ecological consequences of social and economic activities are evident now and will be one of the most pressing problems for society, with a variety of direct and indirect consequences for human life. Energy is a key issue here, not just because of the environmental consequences of energy usage from polluting sources (such as fossil fuels), but also because of the future availability of these sources, which are not limitless (Bhatti and Fazal, 2021; Chien et al., 2021f; Rehman et al., 2021). Indeed, given present global energy consumption levels for a variety of economic and social activities, it is difficult to picture our lives without electricity, for example. Several nations' efforts in renewable energy (RE) provide a lot of optimism for overcoming these obstacles. The agricultural sector, as a source of RE such as biofuel and biomass, which may offer farmers other kinds of income, might play a critical part in this regard. However, due to competition with other crops for land space, biofuel production has posed challenges in some circumstances. On the other hand, we should not overlook the good indirect benefits of biomass generation, such as in the prevention of forest fires (Aziz et al., 2020; Baloch et al., 2021; Chien et al., 2021a; Ehsanullah et al., 2021). The importance of energy whether renewable or nonrenewable is explored by numerous scholars in literature and proposed that there is a significant strong association between both variables (Chien et al., 2022; Hamidov and Helming, 2020; Qiao et al., 2019; Tian et al., 2018).

In recent decades, the agriculture industry of Indonesia has also been the country's major source of employment. However, as Indonesia moves toward industrialization, the agricultural sector's percentage of GDP has been declining which can be witnessed from Figure 1. Being one of the largest producers of plantation crops like palm oil as well as natural rubber the Indonesian Agricultural sector plays a vital role towards the betterment of the country economy. Indonesia, on the other hand, produces a little amount of food and horticulture crops. Horticultural product imports have increased in recent decades, showing that Indonesians now have a more diverse food supply than in the past (Zhao et al., 2021). As a result, farming more profitable fruits and vegetables has a lot of promise for boosting the home market. Every year, the demand for fish and meat increases. Indonesia is the second-biggest poultry bird producer in the Asia Pacific area, as well as one of the world's major seafood producers. However, the income from the fishing industry is far lower than that from land-based agriculture. Despite the fact that ocean waters cover 77% of Indonesia's land area, the fishing industry contributed <3% to the country's GDP (Adebayo et al., 2021; Chien et al., 2021b; Hsu et al., 2021; Prasetyani et al., 2021). In terms of forestry, Indonesia is one of the world's major exporters of tropical wood products, such as plywood, pulp, and paper, which are used to make furniture and handicrafts. However, as Indonesia strives to reduce its deforestation rates, this subsector is likely to expand more slowly in the future. Agriculture is crucial to the well-being of the Indonesian people, there are over 260 million people who work as farmers (40 million people). Agriculture is especially important for national growth since it employs 32% of the labor force, the most of any sector, compared to only 23% for commerce, 16% for services, 13% for manufacturing, and 5% for construction. Agriculture, on the other hand, is not seen as a sufficient source of income for some farmers, as seen by a 1.1 % annual reduction in the number of farmers.

Despite the magnitude of Indonesia's agriculture business, numerous obstacles to realizing its full potential remain, such as a lack of technical innovation and supply chain issues (Chien et al., 2021c; Guritno, 2018; Huang et al., 2021a; Soeparno et al., 2018). Long periods of adverse weather, such as drought, exacerbate these problems by causing shortages of basic commodities including rice, wheat, soybeans, and sugar. In recent years, Indonesian 'agripreneurs' and the government have been reforming the agricultural industry by forming collectives and employing modern farming technologies. Emerging problems, such as the growing need for food availability and the effects of climate change, are already having an influence on Indonesia's agriculture. The country must innovate and incorporate developing digital technology into its agricultural methods more quickly than it has in the past. Improving the agriculture industry through technology might help Indonesia's economy expand more fairly by shortening the long distribution chain from farmers to consumers, reducing its big carbon footprint, and reducing its enormous carbon impact (Balsalobre-Lorente et al., 2019; Chandio et al., 2020; Chien et al., 2021d; Huang et al., 2021b). Indonesian GDP from agriculture from 2014 to 2022 is given in Figure 1.

Figure 1: Indonesian GDP from Agriculture from 2014 to 2022



The present study will address some gaps does exist in the literature like (1) being one of the important topics like RE, non-RE and agriculture although researched although but there are number of its aspects need to be explored yet, (2) Chopra et al. (2022), investigated the association of energy (RE) and development of agriculture in ASEAN whereas the present study will add the non-RE factor and investigate the equation in Indonesian perspective, (3) will test the equation in Indonesia perspective, (4) Chandio et al. (2021), investigated whether RE consumption (REC) and agriculture does matter whereas the present study will add the non-RE factor and investigate the equation in Indonesian perspective, 3) will test the equation in Indonesia perspective, (5) Usman and Makhdum (2021), investigated the association of energy (both renewable and nonrenewable) and agriculture in BRICS nations whereas the present study will test the equation from agriculture from agriculture economics point of view in Indonesian perspective. The significance of the study is (1) help the professional to revamp their policies for best utilization of energy for the betterment of agriculture sector economics in Indonesia, (2) will help the researchers to identify the energy importance for any country agriculture sector.

2. LITERATURE REVIEW

Energy is one of the factors which impact almost the energy aspect of life as well as the country's economy (Chien et al., 2021e; Huang et al., 2021c; Li et al., 2021a; Mohsin et al., 2021). The importance of energy become more vital if the country depends upon agriculture. As the world population is accelerating at a rapid pace which also increased agricultural products demands (Li et al., 2021b; Nawaz et al., 2021; Shair et al., 2021). The demand for agricultural products also results in an increase in energy demand whether it's renewable or nonrenewable. The adverse environmental effect has necessitated the RE production (REP) demand to fulfill the auricular need. In this context: Paramati et al. (2018), explored the nexus between REC and agricultural economic activities in G20 countries. The data set of 32 years from 1980 to 2012 was tested by employing a multiple robust panel econometric model. The results revealed that REC significantly impacts agricultural economic activities like agricultural imports in G20 countries. The study further suggested that the agricultural and RE-related policymakers should aim to initiate effective policymaking with the intention to enhance the foreign direct investment in RE and also agricultural imports in G20 countries. Similarly, Rokicki et al. (2021a) and Xueying et al. (2021), also investigated the energy consumption in the agriculture sector. The data set of 13 years from 2005 to 2018 was tested with the

help of dynamics indicators like the Gini coefficient etc. The results proved the association between consumption of energy, agriculture and economic parameters. Furthermore, Sharma et al. (2021), texted the nexus between agriculture and greenhouse gasses by employing RE as moderating variable in the BIMSTEC region. The data set of 35 years from 1985 to 2019 was tested by employing multiple techniques. The findings of the study proved the relationship between both the variables.

The economy of any country has a reliance on a number of sectors like tourism, energy, agriculture etc. The energy sector of any country is one of the core sectors which plays a vital towards the betterment of the economy. Since the world is witnessing global warming which enhances the need for the production of RE. As energy plays a backbone role in agriculture thus the survival of the agriculture sector strongly depends upon the production of RE. In this context: Martinho (2018) and Xiang et al. (2021), presented an overview of the relationship between RE and agricultural economics over the last decade. There was a total of 91 research papers regarding RE and agricultural economics were reviewed in this context. The study concluded that there is an interrelationship between RE and agricultural economics. One of the basic needs for shifting from natural to REP is environmental degradation. Thus, Chandio et al. (2021), explored the nexus between sustainable environment, agriculture and RE in China. The data set of 25 years from 1990 to 2015 was tested by employing autoregressive distributed lag (ARDL) bound testing. The results revealed that RE, as well as agriculture, does impact environmental sustainability. Furthermore, Ikram et al., (2020) and Tan et al. (2021), also explored this these variables associations. The data set of 14 years from 2000 to 2014 was tested. The results of the study proved variables associations. There are a number of studies that explored the nexus between RE and agriculture economics.

Both RE and non-RE resources play a vital role towards the betterment of any country nature related products like agricultural products, country environment etc. There is a number of studies that highlighted the importance of energy whether renewable or nonrenewable for agriculture (Liu et al., 2021a; Rincon et al., 2019; Yazdanpanah et al., 2021). In this context: Rehman et al. (2021), explored the relationship between RE and non-RE and agriculture in BRICS countries. The data set of 28 years from 1990 to 2018 was tested by employing co-integration and long-run elasticity along with causality test. The study proved the association between non-RE i.e., fossil fuel and agricultural related activities. The study concluded with a recommendation for policymakers to formulate renewable and nonrenewable related policies to achieve sustainable development. Further, Koondhar et al. (2021) and Sadiq et al. (2021c), also explored the nexus between bioenergy, fossil fuel consumption and agriculture bio-economics growth from the Chinese perspective in both the long and short run. The data set of 48 years from 1971 to 2019 was tested by employing ARDL and DYNARDL models. The results proved a positive linkage between the variables i.e., increase in bioenergy and fossil fuel consumption results increase in agriculture bio-economics in China. The study further recommended that China should shift from fossil fuel and non-RE to bioenergy and RE resources with the aim to attain carbon neutrality by the end of 2060. Moreover, Bhatti and Fazal (2021), explored the nexus between modernized agriculture and fossil fuel in ASEAN. The data set of 18 years from 2000 to 2018 was tested by employing panel FMOLS. The results revealed that there is an association between non-RE i.e., fossil fuel and modern agriculture dynamics in BRICS. The study concluded with recommendation that Strategies that increase agricultural production and create active marketplaces for international commerce in ASEAN countries will raise living standards while keeping the environment clean and healthy.

With the passage of time, the importance of agriculture is getting more important for the world. The countries having fertile soil focus more on attaining sustainable development in the agriculture sector. One of the core factors which plays a vital role towards the agriculture sector betterment in the energy. The countries having fewer natural resources in terms of energy production produce a high price for agriculture products due to imported energy resources. The relationship between energy and agriculture is presented by a number of scholars in literature (Aziz et al., 2020; Liu et al., 2021b; Naseem and Ji, 2021; Sadiq et al., 2021b; Usman and Makhdum, 2021). In this context: Xu and Lin (2018), explored the relationship between agriculture and foreign energy i.e. energy imports in China. The data set of 15 years starting from 2000 to 2015 was tested by employing a traditional linear model. The study results proved a linkage between agriculture and foreign energy i.e., energy imports in China. The study further recommended that in order to successfully foster the development of new energy businesses, the government needs to establish diverse policies at various stages. Similarly, Wang et al., (2019) explored the energy and water nexus under the shade of energy mix scenario including energy imports in China. The results of the study revealed that there is an association between energy (in terms of import) and agriculture with a view to ecological point of view. Additionally, Murshed et al., (2020), also explored the significance between energy imported and agriculture and services value-added services. The data set from 1971 to 2018 was tested by employing robust econometric methods. The results revealed that there is no casual impact of the energy (including energy imports) on agriculture and services values added.

The consumption and expense of energy in agriculture have grown, necessitating the adoption of more energy-efficient farming techniques. To accomplish so, the existing systems must be extensively examined. In this context: Alola and Alola (2018) and Sadiq et al. (2021a), explored the nexus between energy and agricultural land use in 16 Coastline countries. The data of 25 years from 1995 to 2015 was tested by employing the ADL approach. The results of the study revealed that there is an association between energy usage and agriculture in selected Coastline nations. The study further suggested that in the region, effective policy implementations based on stakeholder collaboration would enable long-term RE development in the midst of agricultural and tourism activity. Further, Soni et al., (2018) explored the nexus of energy use with agriculture i.e. cropping system in India. The data set of the crop year 2012 to 2013 was tested. The results of the study revealed the use of energy does impact the cropping system in India. Furthermore, Chopra et al. (2022), explored the impact of energy on the sustainable development of agriculture.

The study was conducted on ASEAN nations. The study was conducted in the direction of sustainable development goals introduced by the United Nations. The results of the study revealed that energy consumption does impact agriculture development in ASEAN. Energy usage positively affects the agriculture development in ASEAN. The study further recommended that energy and agriculture-related policymakers should formulate and implement better policies in this regard for the betterment of energy as well as the agriculture sector. There is a number of a scholar who investigated the energy and agriculture relationship and proposed that there is an association between energy and agriculture (Kodirov et al., 2020; Pata, 2021; Zhang et al. 2019).

3. METHODOLOGY

The article examines the impact of REP, REC, fossil fuel energy consumption (FFEC), energy import and energy use on agriculture economics in Indonesia. The researchers have followed the secondary source of data collection such as WDI and extracted data from 1986 to 2020. The equation is given as under:

$$AE_t = \alpha_0 + \beta_1 REP_t + \beta_2 REC_t + \beta_3 FFEC_t + \beta_4 EI_t + \beta_5 EU_t + e_t \quad (1)$$

Where;
AE = Agricultural Economics
t = Time Period
REP = Renewable Energy Production
REC = Renewable Energy Consumption
FFEC = Fossil Fuel Energy Consumption
EI = Energy Import
EU = Energy Use

The present article has taken the agriculture economic as the dependent variable and measured as the agricultural raw material import (% of merchandise import). In addition, five predictors have been used such as REP measured as the REP (% of total electricity output), REC measured as REC (% of total energy consumption), FFEC measured as the FFEC (% of total energy consumption), energy import measured as the EI (% of energy use) and energy use measured as the EU (kg of equivalent per capita). Table 1 shows all the variables and their measurements.

The current research has run the descriptive statistics that show the mean and standard deviation of variables and show the maximum and minimum values of all the understudy constructs. In addition, the research has also run the correlation matrix to check the association among variables. Moreover, the researchers have also run the Augmented Dickey-Fuller (ADF) test to check the unit root among the variables. The equation is given as under:

Table 1: Variables with measurements

S. No.	Variables	Measurement	Sources
1.	Agricultural Economics	Agricultural raw material import (% of merchandise import)	WDI
2.	REP	REP (% of total electricity output)	WDI
3.	REC	REC (% of total energy consumption)	WDI
4.	FFEC	FFEC (% of total energy consumption)	WDI
5.	Energy Import	Energy import (% of energy use)	WDI
6.	Energy Use	Energy use (kg of equivalent per capita)	WDI

$$d(Y_t) = \alpha_0 + \beta t + \mathrm{Y} Y_{t-1} + d(Y_t[-1]) + \varepsilon_t \quad (2)$$

The unit root among construct has been examined individually, and the separate equations for the individual variable are given below:

Agriculture Economics

$$d(AE_t) = \alpha_0 + \beta t + \mathrm{Y} AE_{t-1} + d(AE_t[-1]) + \varepsilon_t \quad (3)$$

REP

$$d(REP_t) = \alpha_0 + \beta t + \mathrm{Y} REP_{t-1} + d(REP_t[-1]) + \varepsilon_t \quad (4)$$

REC

$$d(REC_t) = \alpha_0 + \beta t + \mathrm{Y} REC_{t-1} + d(REC_t[-1]) + \varepsilon_t \quad (5)$$

FEFC

$$d(FFEC_t) = \alpha_0 + \beta t + \mathrm{Y} FFEC_{t-1} + d(FFEC_t[-1]) + \varepsilon_t \quad (6)$$

Energy import

$$d(EI_t) = \alpha_0 + \beta t + \mathrm{Y} EI_{t-1} + d(EI_t[-1]) + \varepsilon_t \quad (7)$$

Energy use

$$d(EU_t) = \alpha_0 + \beta t + \mathrm{Y} EU_{t-1} + d(EU_t[-1]) + \varepsilon_t \quad (8)$$

The current article has run the ARDL model to examine the association among variables, and it is considered the best model when some constructs are stationary at the level, and some constructs are stationary at first difference. ARDL model is also suitable for small samples (Moslehpour et al., 2021; Sharif et al., 2020) as the present article has 35 observations. In addition, the ARDL model generates the short and long-run association among constructs together. In equation (9), δ_1, δ_2, δ_3, δ_4, and δ_5 shows "short-run coefficients;" in contrast, ϕ_1, $_2$, ϕ_3, ϕ_4, ϕ_5, and ε_1 are shows the "long-run coefficients" and the error term. The ARDL model equation is given as under:

$$\begin{aligned}\Delta AE_t = {} & \alpha_0 + \sum \delta_1 \Delta AE_{t-1} + \sum \delta_2 \Delta REP_{t-1} + \sum \delta_3 \Delta REC_{t-1} \\ & + \sum \delta_4 \Delta FFEC_{t-1} + \sum \delta_5 \Delta EI_{t-1} + \sum \delta_6 \Delta EU_{t-1} \\ & + \varphi_1 AE_{t-1} + \varphi_2 REP_{t-1} + \varphi_3 REC_{t-1} + \varphi_4 FFEC_{t-1} \\ & + \varphi_5 EI_{t-1} + \varphi_6 EU_{t-1} + \varepsilon_1 \end{aligned} \quad (9)$$

4. RESULTS

The current research has run the descriptive statistics that show the mean and standard deviation of variables and also show the

maximum and minimum values of all the understudy constructs. Table 2 results show the average value of AE was 4.427% while the mean value of REP was 15.335%. In addition, the figures also show the mean value of REC was 41.687% while the average value of FFEC was 61.468%. Finally, the average value of EI was -83.475%, and the mean value of EU was 728.622%.

In addition, the research has also run the correlation matrix to check the association among variables. Table 3 results exposed that the REP, REC, FFEC and EU have a positive association with AE. Finally, the results also show that EI has a negative association with AE.

Moreover, the ADF test has also been run by the researchers to check the unit root among the variables. The results of the ADF test exposed that AE, REC and EI are stationary at a level while REP, FFEC and EU are stationary at first difference. Table 4 shows these results.

The current article has also used the ARDL bound test to check the co-integration. Table 5 results indicated that calculated f-statistics (4.882) are larger than critical values at a five per cent level of significance that show the co-integration exists and the ARDL model could be used.

The results shown in Table 6 revealed that REP, REC, FFEC, EI and EU have a positive association with agriculture economics in Indonesia in the short run. The results also exposed that 46.5721% of variations in agriculture economics are due to all the predictors used in the study.

The results also revealed that REP, REC, FFEC, EI and EU have a positive and significant association with agriculture economics in Indonesia in the long run because the beta values have a positive sign and t-values are larger than 1.96, and P-values are lower than 0.05. Table 7 shows the long-run association among variables.

5. DISCUSSIONS

The results revealed that REP has a positive impact on the application of agricultural economics. These results are supported by Martinho (2018), which states that when the government encourages the production of RE in the country and provides support through incentives or legal permissions, the firms or individuals involved in the agriculture have many facilities and allowed for many trades or production contracts, as mostly the RE is produced out of agricultural food or non-food crops. Thus, the REP encouragement promotes agricultural economics. These results are also in line with Aydoğan and Vardar (2020), which analyzes the contribution of REP to agricultural economics. One of the major principles of agricultural economics is to enhance agricultural production in a specified period. If there is a tendency to produce energy through the utilization of renewable resources, the cultivation of crops or plants is paid attention to. Thus, the best machinery or processes are applied for having maximum production out of the limited agricultural means of production. These results are also in line with Qiao et al. (2019), which

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
AE	35	4.427	1.501	2.506	7.474
REP	35	15.335	3.246	10.339	23.838
REC	35	41.687	12.152	18.038	58.598
FFEC	35	61.468	4.587	51.853	67.155
EI	35	−83.475	27.265	−144.601	−50.174
EU	35	728.622	146.874	431.260	897.479

Table 3: Matrix of correlations

Variables	AE	REP	REC	FFEC	EI	EU
E	1.000					
REP	0.419	1.000				
REC	0.701	0.556	1.000			
FFEC	0.514	−0.726	−0.818	1.000		
EI	−0.693	0.138	0.735	−0.263	1.000	
EU	0.601	−0.632	−0.912	0.964	−0.443	1.000

Table 4: Unit root test

Augmented Dickey-Fuller Test	Level	t-statistics	P-values
AE	I (0)	−3.112	0.021
REP	I (1)	−6.221	0.000
REC	I (0)	−2.910	0.033
FFEC	I (1)	−6.019	0.015
EI	I (0)	−2.102	0.040
EU	I (1)	−5.991	0.000

Table 5: ARDL bound test

Model	F-statistics	Lag	Level of Significance	Bound test critical values	
				I (0)	I (1)
AE/(REP, REC, FFEC, EI, EU)	4.882	4	1%	5.11	5.42
			5%	3.42	3.91
			10%	2.10	2.88

Table 6: Short run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D (REP)	0.649220	0.298832	2.172253	0.0342
D (REC)	0.798202	0.209219	3.815151	0.0192
D (FFEC)	4.872024	1.498322	3.251654	0.0298
D (EI)	1.291051	0.287294	4.493832	0.0000
D (EU)	1.990269	0.248372	8.013258	0.0000
CointEq(-1)*	−1.298220	0.157281	−8.254144	0.0000
R-squared	0.465721	Mean dependent var		−0.050852
Adjusted R-squared	0.440935	S.D. dependent var		2.225322

Table 7: Long term coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REP	1.198623	0.219853	5.451929	0.0000
REC	3.982114	1.144177	3.480330	0.0019
FFEC	1.175651	0.261687	4.492585	0.0000
EI	3.282038	0.643211	5.102584	0.0000
EU	2.392782	0.823915	2.904161	0.0340
C	0.885174	0.278095	3.182991	0.0233

reveals that the REP accelerates the need for agricultural products as mostly it is the agriculture which provides the raw material for the renewable or clean energy. That is why REP helps apply agricultural economics.

The results revealed that REC has a positive impact on the application of agricultural economics. These results are supported by Ridzuan et al. (2020), which states that the increasing use of RE in the organizations for functioning, transportation, and domestic activities, puts pressure on the government or specific agricultural firms to benefit from the increasing demand by providing timely delivery of quality raw material for RE fuel. This encourages the farmers, ranchers, or owners of agricultural firms to improve their resources like raw material, land, water, labor and others, and allocate them in an efficient manner so that maximum agricultural production can be attained with minimum resources. REP encourages the agricultural economy. These results match with Acosta-Silva et al. (2019), which highlights that REC in the social developmental programs or in accomplishing economic projects keeps the environment clean, healthy, and nutritious for the natural resources grown from land which needs adequate water from the soil and clean atmosphere. REC, thus, encourages agriculture economics. These results are supported by Khan et al. (2018), which indicates that REC in running the machinery or processes of agriculture helps keep the agricultural costs under control and could achieve the desired production of food and fiber products, and livestock commodities with the minimum inputs applied. In this case, agricultural economics can be easily attained.

The results revealed that FFEC has a positive impact on the application of agricultural economics. These results are in line with Hu et al. (2019), which posits that the consumption of fossil fuels within the country for economic purposes like food processing, fiber used in manufacturing, or medication through organic products, enhances the use of natural products from agriculture. The increasing need for agricultural products gives rise to the prices of agricultural products, which motivates the entities interested in the agriculture sector to adopt innovative technologies and agile agricultural processes so that with the minimum resources, maximum better-quality crops, livestock, or related products can be attained. These results also agree with Bilan et al., (2018) and Moslehpour et al. (2022a), according to which, for operating the technologies or infrastructure within the agricultural farms, high voltage power is required, and it can only be acquired with the use of fossil fuels. The agricultural firms which apply fossil fuels for operations can promote their farms and production at an increasing rate with low costs.

The results revealed that energy import has a positive impact on the application of agricultural economics. These results are supported by Moslehpour et al. (2022b) and Rokicki et al. (2021b), which defines import of energy as the acquisition of energy resources from other countries at the time of need and checks its relationship with agricultural economics. The study implies that the import of energy assists the farmers or rancher to continue their agricultural practices, and the continuity of agricultural practices reduces the total costs, enhances profits, and accelerates the opportunities for agricultural development. In this way, the application of agricultural economics is possible in an effective manner. These results agree with Murshed et al. (2020), which denotes that the energy import, having met the needs for energy sources in order to maintain the manufacturing, service providing, food processing, and transportation activities, raises the demands for agricultural commodities like cattle, corn, soybeans, dairy products, misc. Crops, broilers, hogs, wheat, chicken eggs, hay etc. As a result, the increased earnings help the farmers and ranchers to work for agricultural economics.

The results revealed that energy use has a positive impact on the application of agricultural economics. These results match with Rincon et al. (2019), which shows that the consistent availability and utilization of energy at a large scale creates demands for cheap, affordable, and more efficient energy resources. This demand is fulfilled by promoting agricultural economics, as the agricultural products also serve as the RE energy. These results are also in line with Barros et al. (2020), who focuses on the point that the increased use of energy within the agricultural sector helps to properly administer the agricultural practices and encourage enhanced agricultural productivity with minimum resources. So, energy use encourages agricultural economics.

6. CONCLUSION, IMPLICATIONS AND LIMITATIONS

The objective of the study was to examine the influences of RE and non-RE such as REP, REC, FFEC, energy import, and energy use on agricultural economics. The authors managed to do empirical research into the economy of Indonesia and analyzed the REP, REC, FFEC, energy import, and energy use impacts on agricultural economics. According to the study findings, REP, REC, FFEC, energy import, and energy use have a positive relation to agricultural economics. The results stated that the agriculture sector provides material for the REP; so, when there is more REP, the owners of farms or livestock fields pay more attention to the efficient application of agricultural economics. The increased REP in other economic sectors or in agricultural technologies both bring improvement in the agricultural activities; thus, reducing the costs and promoting agricultural economics. The FFEC within the country provides high voltage power to run the machines in agricultural departments, and accelerating the agricultural productivity helps apply agricultural economics. The increase in energy import and energy consumption increases the demand for food or non-food crops or agricultural wastes, which provides a resource for energy production. Moreover, the increase in the energy import and energy consumption for agricultural processes assist in agricultural management and increase agricultural productivity.

The present article secures a distinctive place in the literature because of its great contributions. This study addresses agricultural economics, considering its significance to the country's development. It examines the REP, REC, FFEC, energy import, and energy use and their impacts on the agricultural economics within a country. Many scholars have addressed the relation of RE and non-RE with agricultural economics in their literary

research, but in very few studies, a simultaneous analysis has been conducted. So, the current study with the simultaneous analysis of RE and non-RE for agricultural economics achieves a distinctive place in literature. The present study first time addresses the issue of weak agricultural economics and the impacts of RE and non-RE on agricultural economics in Indonesia. This study also has great empirical significance in the emerging economies as it shows the way to achieve agricultural economics, which is the key to the environmental quality, social wellbeing, and sustainability in economic development. It is useful for government, economists, environmental regulators, and farmers or ranchers as it guides them how, through effective strategies, they can apply agricultural economics. They must form the policies on their own authority to accelerate RE and non-REC and production in order to apply agricultural economics efficiently.

This study still has some limitations. These limitations reduce the reliability of the research, so they require attention from authors. This study examines only energy factors like REP, REC, FFEC, energy import, and energy use and their influences on agricultural economics. Agriculture is a significant sector of the economy, and the agricultural economics application is influenced by many other factors like soil condition, atmosphere, technologies and techniques applied, the resources like seeds, fertilization, and other things, and agricultural management. These factors have a key role in agricultural economics, but the present study does not pay any attention to the influences of these factors on agricultural economics. Through a broader study, these limitations can be removed in future. For the present study, the authors chose the economy of Indonesia so that the impacts of the REP, REC, FFEC, energy import, and energy use on agricultural economics can be captured. A single agricultural system does not provide thorough information about the relation of these factors to agricultural economics. So, in the future, more countries must be selected for research.

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