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Araştırma Makalesi / Research Article

Economic Value of the Use of Chemicals in Agriculture: The Case of European Countries

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Abstract

This study investigates the effects of chemical fertilizers, pesticides, and agricultural lands on gross domestic product. The primary purpose of this study is to prove that conscious chemical support policies should be applied in agriculture to increase yield and quality in agricultural lands. The study's hypothesis is; when fertilizers and pesticides are used in fertile agricultural lands, the agricultural sector's contribution to the gross domestic product increases. Panel data analysis was conducted for 27 countries covering 2000-2020. In the analysis, the contribution of agriculture to the gross domestic product is taken as the dependent variable. Independent variables are the amount of chemical fertilizer used, hectares of agricultural lands, and pesticides used. The analysis concluded that chemical fertilizers and pesticides affected the dependent variable significantly and positively. In addition, it is understood that the dependent variable's most influential factor is agricultural land. As a result, to increase agriculture's contribution to the gross domestic product, countries should educate farmers about the effects and correct use of pesticides and fertilizers. Thus, agricultural productivity and product quality will be increased.

Keywords: *Agriculture, GDP, Fertilizer, Panel Data Analysis.*

Tarımda Kimyasal Kullanımının Ekonomik Değeri: Avrupa Ülkeleri Örneği

Öz

Bu çalışmada kimyasal gübrenin, böcek zehirinin ve tarım arazilerinin tarımsal gayrisafi yurt içi hasılaya etkisi incelenmiştir. Bu çalışmanın temel amacı; tarım arazilerinde verimi ve kaliteyi artırmak için tarımda bilinçli kimyasal destek politikalarının uygulanması gerektiğini kanıtlamaktır. Çalışmanın hipotezi; verimli tarım arazilerinde uygun ölçüde gübre ve böcek zehiri kullanıldığında tarım sektörünün gayrisafi yurt içi hasılaya katkısı artmaktadır.

27 ülke için 2000-2020 dönemini içeren panel veri analizi yapılmıştır. Analizde tarımın gayrisafi yurt içi hasılaya katkı payı bağımlı değişken olarak alınmıştır. Bağımsız değişkenler; kimyasal gübre kullanım miktarı, tarım arazilerinin hektarı ve kullanılan böcek zehiri miktarıdır. Analizde kimyasal gübre ve böcek zehiri kullanımının bağımlı değişkeni önemli ölçüde, pozitif yönde etkilediği sonucuna ulaşılmıştır. Ayrıca bağımlı değişken üzerinde en etkili faktörün tarım arazileri olduğu anlaşılmıştır. Sonuçta tarımın gayrisafi yurt içi hasılaya katkısını arttırmak için ülkeler tarım ilaçlarının ve gübrelerin etkileri ile doğru kullanımı konusunda çiftçilere eğitim vererek, çiftçileri eğitmelidirler. Böylece tarımsal verimlilik ve ürün kalitesi artırılacaktır.

Anahtar Kelimeler: *Tarım, GSYH, Gübre, Panel Veri Analizi.*

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INTRODUCTION

Soil is one of the indispensable elements of life, like water and air. Soil is the place of installation for production facilities and residences, the place of growth for forests, the provider of food for livings things, and the raw material of many industries. Therefore, the soil has an important place in the lives of livings things. For this reason, it is necessary to use the soil consciously by scientific rules, to protect it, and to establish a data bank. In addition, while the world population is annualy increasing, the amount of fertile land is decreasing.

For this reason, land should be used rationally, and nature should not be allowed to deteriorate while providing economic growth with industrialization and urbanization. In addition, global warming, drought, increasing world population, and difficult living conditions brought about by climate change require more efficient use of existing food resources. For this purpose, the quality of existing products should be increased (Bayram & Elmacı, 2013).

In this direction, the study aims to prove and interpret the econometric method that conscious chemical support policies should be applied in agriculture to increase yield and quality in agricultural lands. Therefore, this study hypothesizes that when fertilizers and pesticides are used in fertile agricultural lands, the agricultural sector's contribution to the gross domestic product increases. This study has a different fundamental idea because studies in the literature covers different themes, periods, countries, and methods. Also, the original contribution of the study is that it examines the effects of fertile farmland, fertilizer, and pesticide use on GDP together. In the studies in the literature, the effects of fertile agricultural lands, fertilizer, and pesticide use on GDP were examined separately in each article. Besides, we choosed chemical fertilizers and pesticides as independent variables to see the effect of these variables on agricultural productivity. Because chemical fertilizers and pesticides negatively affect the nature and human life. If chemical fertilizers and pesticides are not very effective on agricultural productivity, should people abandon the use of chemical fertilizers and pesticides in agriculture?

Nitrogen is the most important plant nutrient among in today's commercial fertilizers. In 1840, there was a scientific debate in Europe about the importance of nitrogen for plant growth (Page & Herment, 2021). British scientists Bennet Lawes and Joseph Henry Gilbert published a study showing that nitrogen fertilizers increase wheat yield in England. In 1898, industrialized nations began to worry about how to feed their growing populations. England, for example, was importing most of its wheat. In 1898, William Crooks, president of the British Association for the Advancement of Science, urged chemistry researchers to find solutions to help to solve the impending food crisis. In 1909, German scientist Fritz Haber discovered the chemical reaction of nitrogen and hydrogen-derived ammonia, the main component of nitrogen-based fertilizers. In July of the same year, BASF, Germany's largest chemical company, financed German chemist Carl Bosch to develop commercial-scale ammonia production. Today, a modern ammonia production facility produces approximately 1,000 tons daily. These advances in ammonia production have significantly increased the yield of food and feed crops (Louchheim, 2014).

Fertilizer is the minerals that are given to the soil in order to increase plant production. Fertilization is putting these minerals into the soil (Karakurt, 2009). Fertilization is almost a necessity to increase productivity in agricultural production. Primarily fruit trees draw a severe amount of nutrients from the soil yearly. If the nutrients lost by the soil due to fruit trees and other plants are not replenished every year, nutritional deficiencies that cause a decrease in

yield are observed in the trees. Therefore, plants and trees should be supplemented with sufficient fertilizer [Demirci Chamber of Agriculture (DZOB), 2016]. Fertilization has two primary purposes. These are [Erzurum Governorship- Provincial Directorate of Agriculture and Livestock (ETHM), 2013]: To eliminate mineral deficiency in the soil, to provide a better nutrient environment for the plant.

To increase the effectiveness and benefit of fertilizer use, the following should be done: The number of plant nutrients in the soil should be determined correctly, fertilizers should be applied to the soil at the appropriate time, with the appropriate method and extent; in order to fertilize at the appropriate level, the condition of plant nutrients in the soil should be well known (ETHM, 2013).

It is possible to list the benefits of fertilization as follows: By increasing power of the soil, its productivity is increased; quality product is obtained; soil productivity becomes sustainable, the chemical structure problem in the soil is eliminated, microorganism activity in the soil is increased, plant nutrients removed from the soil via different factors (wind, water, etc.) are regained to the soil (ETHM, 2013).

The world population is expected to reach ten billion by 2050. For this reason, people's need for agricultural products, one of the most important links of the food chain, will increase. For this reason, soil fertility should be increased as much as possible and agricultural products should be taken from the unit area. Spraying is one of the most effective methods of protecting agricultural products against diseases, harmful insects, fungi, and weeds. Nevertheless, pesticides are harmful to plants, insects, diseases, etc. It also harms the natural environment. However, the surfaces affected by pesticides are different. For example, pesticides with a contact effect do not harm the plant's tissues. Semi-systemic pesticides, another type of pesticide, are effective in the tissues where the drug is applied but do not affect other parts of the plant. Apart from these, systemic pesticides provide strong protection by going down to the root of the plant no matter where they are applied to the plant (Savaşan-Söğüt, 2018).

Global demand for pesticide and fertilizer production and use has steadily increased. Global sales are increasing at a rate of approximately 4.1% per year. In addition, the sales volume is estimated to reach 309 billion USD by 2025. Consequently, the global target of reducing the use of chemical products in agriculture has yet to be achieved. Nowadays, according to UNEP (UN Environment Program), improving food safety and nutritional quality with pesticides and fertilizers, which have many benefits related to agriculture, is still the primary goal. However, current and projected use and production and the lack of effective management cause many adverse effects on the environment and health throughout their lifecycle. According to UNEP, pesticides, in particular, cause approximately 11,000 deaths and roughly 385 million non-fatal pesticide poisonings each year (Cavallito, 2021).

Besides, when pesticides are used unconsciously or indiscriminately, they cause chemical residues on the plant. It is not always possible to remove these chemical residues from the plant using washing and peeling methods. However, it is possible to remove or reduce the number of chemical residues from agricultural foods by using different methods (solutions, washing, ozonation, etc.) depending on the type of pesticide used (Savaşan-Söğüt, 2018).

Agricultural spraying is one of the most critical components that have increased production since the 1940s. Agricultural spraying is one of the most used methods because it is practical, quick, and easy to use. The preference rate in the fight against diseases, pests, and weeds is 95%

(Turabi, 2007). Because chemical control's effectiveness is high and economical when used consciously, it can protect the agricultural product against microorganisms that secrete toxins (Durmuşoğlu, et al., 2010). The decrease in quality and yield is approximately 60% in the products where agricultural spraying is not applied (Turabi, 2007).

The amount of pesticide production in the world is three million tons, and the annual sales amount is approximately 25-30 billion USD. Therefore, the world pesticide market is growing at an average of 1% per year based on tonnage (Dağ et al., 2000).

When agricultural spraying is done consciously, the producer obtains a quality product, the producer's profitability increases, and the storage period of the agricultural product is extended. However, unfortunately, 1/3 of the cultivated plants in Türkiye cannot be brought into the economy due to diseases and harmful organisms (Kansu, 1994).

Therefore, agricultural disinfection is of great importance. It is a fact that the amount of agricultural products is increased by chemical spraying. Chemical disinfection also increases the quality of the product. For example, the loss rate caused by organisms and weeds is about 27%, although chemical disinfection is applied to the wheat plant. Nevertheless, without chemical disinfection, the loss rate could have reached 53%. Similarly, without chemical disinfection, the average loss rate for corn and barley would be 52% and 40% over the years (Dağ et al., 2000).

While the world population was three billion in 1961, it increased to 7.84 billion in 2021. (World Bank, 2022a). While the area allocated to agriculture in the world was 44.790.648 km^2 in 1961, it was only 47.388.929 km^2 in 2020 (World Bank, 2022b). While the world population has more than doubled, agricultural lands have increased only slightly. For this reason, modern agricultural techniques have realized the food production needed for people's nutrition. Thanks to modern agricultural methods, meat, fruit, vegetables, cooking oil, etc., staple food production has been tripled. However, it is impossible to carry out intensive agriculture without applying effective and conscious plant protection measures (Dağ et al., 2000; Durmuşoğlu et al., 2010).

In other words, using plant protection products is essential for producing quality agricultural products in the required quantity. In the past, life-threatening fungal diseases such as rye spur, which caused the death of thousands of people in Europe, and the formation of fungal toxins such as aflatoxin, which causes cancer, can be prevented during the production and storage stages of products via using plant protection products (Dağ et al., 2000).

In addition, unconscious or excessive use of pesticides causes the following problems in terms of human health and nature as follows: Pesticides contain some toxic substances, pesticides cause nervous system diseases, birth abnormalities, and cancer; according to the applied pesticide and application method, it causes environmental pollution; some decomposition products may be more toxic and persistent than the parent pesticide, it causes the death of beneficial organisms, excessive pesticide use can cause pollution of the air we breathe (Delen, 2008).

There are damages fertilizer and pesticides to people and the environment as follows: Chemicals cause the accumulation of toxic chemicals that are very dangerous to the human body. Chemical fertilizers cause air, soil, and water pollution. However, the soil quality decreases over time (Chandini et al., 2019). Excessive fertilization lead soil salinity, heavy metal accumulation, and eutrophication with nitrate accumulation in water; furthermore, it can cause the greenhouse effect via the emission of nitrogen and sulfur-containing gases (Savci, 2012), and

it can reason air pollution (Bisht & Chauhan, 2020). In addition, pesticides cause soil and water pollution (Özkara et al., 2016). They also cause chronic diseases in humans. Pesticides affect people of all ages, including prenatally (Rajmohan et al., 2020).

Animal manure, soybean, or rapeseed pulp can be used to reduce the harmful effects of chemical fertilizers on the environment and human health (Cen et al., 2022). In addition, improved plants can reduce pesticide use (Jacquet, et al., 2022). It is one of the options in organic farming (Muller et al., 2017). However, anyone of these applications can not replace chemical fertilizers and pesticides in achieving the desired agricultural yield.

Soil is the fundamental element for the continuity of life of all living things on earth. With the damage to the soil, it becomes riskier against dangers such as climate change, drought, global warming, landslide, erosion, and flood (Özyol, 2022).

The effective use of arable agricultural lands is essential in terms of food supply in line with the growth rate of the world population. Therefore, sustainable land management aims to protect the soil and use agricultural lands efficiently (Kurugöllü & Ünel, 2021).

As cities expand around the world, fertile agricultural lands often disappear. Surfaces such as asphalt and concrete impair the permeability of the soil, preventing the soil from performing its functions, such as accumulating water, providing living space for living things, regulating the climate, producing food, and cleaning harmful chemicals. Rain falling on impermeable surfaces (asphalt, concrete, etc.) in cities cannot pass through the soil and mix with groundwater; it causes floods in city centers. Cities, railroads, roads, and canals tear the earth's surface apart, damaging biodiversity. However, the EU aims for "zero land loss by 2050". Commercial and industrial regions and cities are destroying fertile farmland. Harmful substances are mixed into the soil from many industrial, agricultural, and residential areas. The substances in question are stored in the soil; may participate in groundwater, rivers, and seas. At first, harmful substances released into the air can be stored in the soil after rain. In recent years, while agricultural productivity has increased in the EU, the total area used for agriculture has decreased. Intensive agriculture based on fertilizers and crop protection methods damages fertile farmland [European Environment Agency (EEA), 2019].

2. LITERATURE

Many studies are related to using pesticides and fertilizers in agricultural areas in literature. These studies generally focus on two views (the use of pesticides and fertilizers is necessary and unnecessary for agriculture), as follows:

Pesticides are an essential agricultural control method used to protect the product from the damage of diseases, pests, and weeds and to produce quality products. In addition, using fertilizers increases the soil's fertility by eliminating mineral deficiency. An agricultural system that does not use pesticides and fertilizers is far from realism due to the increasing population and decreasing arable land. The use of pesticides and fertilizers has become mandatory to meet the increasing food needs of the world's increasing population. Only if agricultural productivity increases do the country's GDP also increase (Akdoğan etc., 2012; Dinç, 2022; Gönay Akbaş & Bağcı, 2021; Kaymak, 2015; Köseoğlu & Ünal, 2019; Okine & Özel, 2018).

McArthur & McCord (2017) examined the importance of fertilizer use in agriculture in countries in Asia, Africa, and the Americas using the panel data method. Their study concluded

that as fertilizer consumption increases in a country, its GDP increases significantly within five years (McArthur & McCord, 2017).

Hedlund et al. (2019) examined the relationship between pesticide use and economic development between 1990 and 2014. As a result of their investigation, they found that there was a positive relationship between pesticide use and economic development over the years (Hedlund, et al., 2019).

According to Nikkei's (2022) research, there is a close relationship between chemical fertilizers and agricultural productivity. Because of the economic crisis in Sri Lanka in 2022, Sri Lanka's fertilizer imports decreased. Therefore Sri Lanka's agricultural productivity decreased by about 8.5%.

Tudor et al., in their study using data from Romania, Germany, Spain, France, Italy, Hungary, Poland, and the United Kingdom, examined the effects of chemical fertilizer and pesticide use on wheat yield. In their study, they concluded that the use of chemical fertilizers and pesticides increased wheat yield in general. Tudor et al., used a multiple regression model in their study (Tudor, et al.,2023).

Chemical pesticides and fertilizers are synthetic toxic substances and can form residues in plant products with soil, water, and air for a long time. For this reason, although chemical pesticides cause some deterioration in human and environmental health and the region's ecology, agricultural production is predicted to decrease gradually over the years, and production in these areas will no longer be possible. Therefore, fertilizers and pesticides should not be used in agriculture (Kaplan, 2016; Şahin, 2016).

3. METHODOLOGY

In this study, panel data analysis was used. This method analyzes cross-sectional observations of units (individuals, households, companies, countries) in a certain period (Greene, 2012). In panel data analysis, time series are used. There are two dimensions: section and time series (Hsiao, 2006). A general panel data model is written as (Hsiao, 2003):

$$Y_{it} = \alpha_i + X_{it}\beta + u_{it} \qquad i = 1,\ldots..,N; \qquad t=1,\ldots,T \qquad (1)$$

In the equation, α is the constant parameter, β is the slope parameter, u is the error term, and i units (individuals, households, firms, countries), Y is the dependent variable. Finally, t represents time (day, month, and year) (Hsiao, 2003).

The cross-section dependency test is applied in the first stage, and the first-generation and second-generation unit root tests are applied. Cross-sectional dependency testing aims to understand whether first-generation or second-generation unit root tests can be applied. Panel unit root tests are similar to, but not identical, unit root tests performed on a single series. In the first-generation panel unit root models, the characteristics of panel unit root tests are analyzed, assuming that the data are distributed independently and identically across the units (Barbieri, 2005). Second-generation unit root tests, on the other hand, take into account the possible dependence between units (O'Connell, 1998).

In the second stage, the Mundlak test was applied. The Mundlak test is used to choose between fixed and random effect equations. In Mundlak's approach, a functional form condition is sought between individual and group variables to determine the dependence between

individual and group variables (Mundlak, 1978). The Mundlak approach allows increasing the random effects with variables that need to detect the correlation between regressors and personal effects. The Mundlak approach offers a real benefit by providing a statistical basis for distinguishing exogenous and endogenous explanatory variables. In this sense, Mundlak's approach is more efficient than the Hausman test as it only detects the presence of correlation. In addition, since Mundlak's approach is based on a random effect, it allows the continuous estimation of the effect of time-constant variables. However, the regressors and personal effects are not independent (Debarsy, 2012).

In the third stage, heteroscedasticity, autocorrelation, and inter-unit correlation tests were applied. The heteroscedasticity and inter-unit correlation test results are positive, while the autocorrelation test results are negative. Therefore, a "robust" panel data test was performed in the last stage. In order to examine the effects of agricultural lands and the number of fertilizers and pesticides used on agricultural GDP.

4. DATA TYPE AND SOURCES

In the study, 27 European countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Türkiye) data are used. The data cover the period 2000-2020. Data from FAO and the World Bank are real and annual.

5. EMPIRICAL RESULTS

The study's dependent variable is the agricultural sector's share of GDP. The independent variables are the amount of fertilizer used, pesticide use, and agricultural land. The reason for choosing these variables (chemical fertilizer, pesticide) proves that the desired increase in agricultural productivity is achieved by using chemical fertilizers and pesticides, despite all their harm. Therefore, there is a cross-section dependency necessary for panel data analysis. Because the obtained result reveals that the first-generation or second-generation unit root test can be applied to the variables, when there is cross-section dependence, second-generation unit root tests can use, and there is no cross-section dependence, first-generation unit root tests can use.

Table 1: Cross Section Dependency Test

Variables	CD-Test	p-value	Average joint T	Mean ceA	Mean Abs	Result
lnb	0.83	0.407	21.00	-0.01	0.42	-
lnt	11.811	0.000	21.00	0.14	0.63	+
lng	7.523	0.000	21.00	0.09	0.42	+
p	11.276	0.000	21.00	0.13	0.42	+

The result of cross-section dependency shows that second-generation unit root tests can be applied. Since the p-value of lnb is greater than the critical value of 0.05, the first-generation unit root test will be applied. Since the p-values of the other values are less than the critical value of 0.05, the second-generation unit root test will be applied (Table 1). Pesaran test, one of the second-generation panel unit root tests, was used in the study.

Table 2: lnb Breitung Unit Root Test

	statistic	p-value
lambda	-2.518	0.0059

lnb is constant, because p-value<0,05 (Table 2). The Breitung test tests the null hypothesis that there is a standard unit root. This method requires determining the lag numbers used in each exogenous variable and cross-section ADF regression. In the test, individual constants, trends, or individual constant terms (constant effects) can be used, but exogenous variables can not be used. The Breitung test does not require kernel calculation.

Table 3: Second Generation Unit Root Test

Variables	CIPS	Critical Values		
		%10	%5	%1
lnt	-2.032	-2.07	-2.15	-2.30
ft	-3.984	-2.07	-2.15	-2.32
lng	-2.027	-2.07	-2.15	-2.30
fg	-5.133	-2.07	-2.15	-2.32
p	-2.203	-2.07	-2.15	-2.30
fp	-5.529	-2.07	-2.15	-2.32

f values are constant, because CIPS value > critical values (%10, %5 , %1) (Table 3). f variables are suitable for analysis.

Table 4: Mundlak Test

Tests	Mundlak Test	Result
Result	Prob > chi2= 0.0000	fixed-effect

Afterward, the Mundlak test was applied. First, the Mundlak test chooses between fixed-effect and random-effect equations. Because the Mundlak test result (0.000) was less than the critical value of 0.05, the fixed effects model was preferred (Table 4). The next step applied heteroskedasticity, autocorrelation, and inter-unit correlation tests.

Table 5: Reliability Tests

Tests	Test Values	Result
Heteroscedasticity	Prob>chi2 = 0.0000	**+**
Autocorrelation	modified Bhargava et al. Durbin-Watson = 2.768 Baltagi-Wu LBI = 2.853	**-**
Inter-unit Correlation	Pr = 0.0000	**+**

The results of heteroskedasticity and inter-unit correlation tests are positive, while the autocorrelation result is negative (Table 5). These results may bias the analysis result. Therefore, a "robust" panel data test was applied in the last stage.

Table 6: Panel Data Analysis (FGLS)

Variables	Coef	Std Err.	z	P>|z|	[95% Conf. Interval]
ft	12.072	2.893	4.17	0.000	6.401 17.744
fg	3.053	0.910	3.35	0.000	1.269 4.837
lnb	0.260	0.107	2.42	0.001	0.049 0.471
cons	-1.995	1.017	-1.96	0.005	-3.990 -0.000

The independent variables are agricultural land (ft), fertilizer (fg), and pesticide (lnb) amounts, which are statistically significant. The analysis concluded that chemical fertilizers and pesticides had a significant positive effect on the dependent variable. In addition, it is understood that the most effective factor on the dependent variable was agricultural land, because one unit increase in agricultural lands provides twelve units rise in agricultural GDP. However, one unit increase in fertilizer use increases agricultural GDP by three units. In addition, one unit increase in pesticide use increases 0.26 units in agricultural GDP (Table 6). As a result, chemical fertilizers and pesticides significantly increase agricultural GDP.

6. CONCLUSION AND RECOMMENDATIONS

Today, 25% of the world's population lives below the poverty line. Poverty is more common in underdeveloped and developing countries. The reasons for this negative view are global warming, barriers to international trade, food requirements of the increasing world population, wrong policies, and inefficient use of food resources. Solution proposals; can be summarized as making conscious fertilization, the intended use of pesticides, and developing policies for protecting agricultural lands. Fertilization ensures that the nutrition is sustainable.

The soil loses some minerals via rain, wind, flood, etc. However, the soil can regain the minerals with chemical fertilizers. Thus agricultural productivity increases. According to analysis results, one unit increase in the use of chemical fertilizers increases GDP by three units. Besides, insects cause great damage to agricultural yields. They cause product loss. Agricultural pesticides are used to reduce this loss as much as possible. The use of pesticides increases agricultural productivity by reducing product loss. According to analysis results, a one-unit increase in pesticide use increases agricultural GDP by 0.26 units. Of course, more important than the use of chemical fertilizers and pesticides is to have fertile agricultural lands. Because only chemical fertilizers and pesticides contribute more to agricultural productivity, discussing agricultural income with fertile agricultural lands is possible. We can see this effect from the analysis results. According to the analysis results, a one-unit increase in fertile agricultural lands increases the agricultural GDP by twelve units. Therefore, policymakers should make intense efforts to protect fertile agricultural lands.

The following recommendations can be made to policymakers in order to protect the food supply: Sustainable and environmentally friendly agricultural practices should be given importance, and misuse of pesticides should be prevented by training farmers on the effects

and correct use of pesticides. At the same time, customers that buy products, should be directed to enterprises with controlled agriculture; the government can take a medium rate fertilizer and pesticide tax from farmers when farmers use excessive chemical fertilizers and pesticides. Thus, farmers learn that they will be punished when an overdose of fertilizer or pesticide is used; the government can take ecological compensation from farmers if farmers overdose on fertilizers or pesticides so that excessive doses of chemical fertilizers and pesticide use can be prevented.

AUTHOR STATEMENT

Statement of Research and Publication Ethics

This study has been prepared in accordance with scientific research and publication ethics.

Author Contributions

The authors contributed equally to the study.

Conflict of Interest

There is no conflict of interest between the authors related to the study.

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