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The Effect of Global Warming on Changes in the Labor Structure of the Agricultural Sector

Faradiba Faradiba

Department of Physics Education
Jl. Mayjen Sutoyo No 2. Jakarta 13630 - Indonesia

Abstract – The issue of global warming is an important agenda for all countries in the world. Global warming will have a negative impact on human life in the future if it is not properly anticipated. One of the threats from global warming is the agricultural sector. The agricultural sector plays an important role in human life. Because the agricultural sector is considered unpromising, the knock-on effect is a lack of public interest in developing the agricultural sector. Therefore, this research aims to determine changes in temperature in various countries on the percentage of workers in the agricultural sector. The data used in this research is temperature data from Climatewatch and also data on the percentage of agricultural sector workers from the World Bank. The method used in this research is linear regression. The results of this research indicate that changes in temperature have an impact on people's interest in working as farmers. Apart from that, the issue of shifting people's livelihoods out of the agricultural sector occurs for both male and female farmers. For this reason, an extra role is needed from the Government to encourage public interest through boosters in the agricultural sector so that public interest in the agricultural sector and agricultural production remains well maintained.

Keywords – Global warming, farmers, climate, OLS.

I. Introduction

Global warming has become one of the most pressing issues and dominates the world's priority agenda today. Its increasingly felt impact has changed the dynamics of people's lives significantly. Increasing global temperatures have caused drastic climate change, triggered natural disasters, and threatened environmental sustainability (Adger & Brooks, 2003; Huppert & Sparks, 2006; Myers & Patz, 2009). One aspect that is directly affected is ecosystem imbalance. Global warming accelerates the process of climate change, causing extreme weather and rising global temperatures. This causes a loss of biodiversity and changes in animal and plant migration patterns. Previously stable ecosystems have become vulnerable to extreme changes, threatening the sustainability of life on the planet.

At the social level, society also feels a significant impact due to global warming. Extreme temperature increases can cause natural disasters such as floods, droughts, and storms, which damage infrastructure and threaten the safety of residents. Apart from that, the agricultural and food sectors are also affected because climate change affects crop production and the sustainability of natural resources that support food security (Kogo et al., 2021; Maja & Ayano, 2021; Mbow et al., 2020).

Global efforts to tackle global warming are becoming increasingly urgent. Cooperation between countries, companies, and individuals is key to reducing greenhouse gas emissions and taking steps to stop environmental degradation. Awareness of the urgency of the global warming issue is also increasing, triggering concrete actions such as investment in environmentally friendly technology, promotion of sustainable lifestyles, and development of renewable energy sources.

Global warming has had a serious impact on the agricultural sector, creating major challenges in maintaining food availability throughout the world (Anderson et al., 2020; Malhi et al., 2021; Sarkar et al., 2020). Climate change caused by global warming has caused extreme weather variations, such as extreme high temperatures, droughts, or unpredictable floods. All this puts extra pressure on agriculture and crop production. One of the most pronounced impacts is changes in planting and harvest patterns.

Corresponding Author: Faradiba Faradiba

Rising global temperatures and unpredictable weather changes make it difficult for farmers to plan planting and harvesting times appropriately (Arum, 2022; Raihan, 2023; Shahzad et al., 2021). Increasing droughts and more frequent flooding can destroy crops and damage harvests, resulting in significant reductions in food production.

Apart from that, climate change also affects plant productivity and soil quality (Corwin, 2021; Lal, 2020; Liliane & Charles, 2020). Increasing temperatures can trigger changes in soil properties and disrupt the balance of agricultural ecosystems. Plants that are accustomed to certain conditions become more susceptible to diseases and pests, which in turn can reduce crop yields and the quality of agricultural products.

Global food availability is becoming increasingly vulnerable due to instability in agricultural production. Food scarcity can occur due to low production, which ultimately affects the price and accessibility of food for the community. Therefore, global efforts to overcome global warming must also focus on adaptation strategies in the agricultural sector, such as the development of crop varieties that are resistant to climate change, sustainable agricultural techniques, and wise management of natural resources.

Uncertainty involving the agricultural sector has had a significant impact on people's interest in being involved in agricultural businesses. This condition creates serious challenges for the development and sustainability of this sector. The existence of uncertain factors, such as climate change, fluctuations in agricultural commodity prices, and economic instability, makes prospective farmers reluctant to enter the world of agriculture.

One of the main impacts of this uncertainty is the decline in the younger generation's interest in careers in the agricultural sector. Young people tend to look for opportunities in other sectors that are considered more stable and promising. Increasing weather uncertainty, such as extreme drought or natural disasters, poses a high risk to agricultural output and contributes to a decline in their interest in engaging in agricultural business.

Apart from that, fluctuations in agricultural commodity prices are the main factor influencing business actors' intentions to get involved in this sector. Unstable prices can result in income uncertainty, making many people hesitant to take risks in the world of agriculture. The lack of guarantees of definite profits makes some people prefer other business sectors that are considered more financially reliable.

To overcome this challenge, there needs to be a joint effort from the Government, agricultural institutions, and the private sector to create a more stable and attractive environment for agricultural business actors. This includes developing policies that support sustainable agriculture, providing incentives to motivate farmers, and investing in agricultural technologies that can increase productivity and reduce risks.

The problem of low interest in the agricultural sector, in addition to climate problems, which have become the main focus, creates serious challenges, especially when we look at the impact on the availability of world food stocks. The younger generation tends to be less interested in being involved in agricultural activities, which could lead to a lack of young farmers taking over the sector in the future.

Several factors that cause low levels of interest include the perception that agriculture is a less attractive and financially profitable profession. This view is accompanied by the impression that life in the countryside is less attractive than the opportunities in the city. Technology and innovation in agriculture may not be fully included in educational approaches, so young people do not understand the potential and challenges that can be overcome through modern agricultural practices.

Lack of financial support and access to the latest agricultural technology is also a barrier for young people interested in getting involved in this sector. This condition hampers innovation and development in the agricultural sector, complicating efforts to increase productivity and maintain global food security.

To overcome this threat, steps are needed that focus on reviving the younger generation's interest in agriculture. This can involve educational programs that promote an understanding of modern agricultural technology and provide insight into career opportunities in the sector. Government support in the form of financial incentives and the provision of adequate infrastructure in rural areas is also key to increasing the attractiveness of the agricultural sector.

In addition, there needs to be a change in society's perception of agriculture as a respectful and empowering profession. Highlighting the vital role of farmers in providing food for the global population and maintaining environmental sustainability can

help create a more positive image associated with employment in the agricultural sector. In this way, we can move towards sustainability in the agricultural sector and safeguard the world's food supply for the future.

There have been many qualitative studies and researchers' arguments that state that regional temperatures will have a negative impact on agricultural production (Nhemachena et al., 2020; Skendžić et al., 2021; Warsame et al., 2021). This research aims to determine the effect of climate change in various countries on the structure of the workforce in the agricultural sector. Through this research, it will be known whether higher temperatures will have a negative impact on labor absorption in the agricultural sector. This research will also classify based on gender.

This research makes an important contribution to our understanding of the dynamics between temperature and labor engagement in the agricultural sector. The results can be the basis for better policy planning, adaptation measures, and mitigation efforts in the face of climate change, which can impact the sustainability of the agricultural sector and global food security.

II. Data and Methodology

This research uses temperature data obtained from ClimateWatch and data on the percentage of the agricultural sector workforce from the World Bank as a basis for analysis. The combination of these two datasets provides a holistic picture of the relationship between temperature and labor engagement in the agricultural sector, resulting in a deeper understanding of the impact of climate change on this key sector.

Temperature data obtained from ClimateWatch provides an overview of global temperature change patterns during certain periods. This information is the basis for looking at temperature trends and fluctuations that may have an impact on agricultural sustainability. In contrast, data on the percentage of the agricultural sector workforce from the World Bank provides a perspective on how much society is involved in agricultural activities in a global context.

The analytical method used in this research is linear regression. This approach was chosen to understand the relationship between temperature variables and the percentage of labor in the agricultural sector more systematically. Linear regression allows researchers to identify patterns or trends in data and evaluate the extent to which temperature may affect labor in the agricultural sector (Bai et al., 2021).

The use of temperature and labor data in the agricultural sector from two different sources strengthens the validity of the research results. This allows researchers to gain a more comprehensive understanding of the impact of climate change on community participation in agriculture. In addition, the linear regression method provides a powerful statistical framework for analyzing the correlation between the variables studied.

III.Results and Discussion

Climate change that occurs over the long term provides a clear signal of an increasingly worrying increase in global temperatures (Bandh et al., 2021; Lomborg, 2020). This trend not only reflects ordinary natural phenomena but also indicates the real impact of global warming that is currently occurring. The fact that the world's average temperature continues to increase is a serious reminder that concrete action is needed to address climate change and its impacts.

Global warming, as the main cause of climate change, has serious consequences for the environment and human life. Rising global temperatures can trigger extreme weather phenomena, such as more severe storms, prolonged droughts, and rising sea levels. All of this has the potential to harm the ecosystem and threaten the sustainability of life on Earth.

It is important to recognize that global warming is not an endpoint but rather an urgent warning signal for action. Adaptation and mitigation measures must be implemented globally to reduce the impacts of climate change and maintain the sustainability of the planet. Efforts to reduce greenhouse gas emissions, protect forests, and develop renewable energy are the keys to mitigating global warming and keeping the Earth's temperature within safe limits.

International involvement and cooperation are also crucial in overcoming climate change. Countries around the world need to unite to implement policies that support emission reduction, environmental conservation, and adaptation to inevitable change. Apart from that, public education and awareness about the importance of environmental conservation are also very important so that individuals can participate in efforts to protect the Earth.

Figure 1 provides a clear picture of global climate change trends, showing that increases in world temperatures occur not only in the short term but also in the long term. The data illustrated in the figure reflects a consistent rise in average annual temperatures, creating a picture of ongoing and deepening climate change.

In the short term, the image can reflect temperature fluctuations that may be related to natural factors, such as El Niño or La Niña (McPhaden et al., 2020). However, what is more striking is the long trend showing a continuous increase in temperatures in recent decades. This increase not only includes Earth's surface temperature but also involves changes in other climate parameters, such as rainfall patterns, storm intensity, and drought.

It is important to understand that long-term, persistent increases in temperature have a profound impact on many aspects of life on Earth (Merrey et al., 2018). These include changes to ecosystems, animal migration, and even shifts in agricultural patterns. This phenomenon can stimulate significant ecological changes and threaten the balance of nature and the sustainability of natural resources.

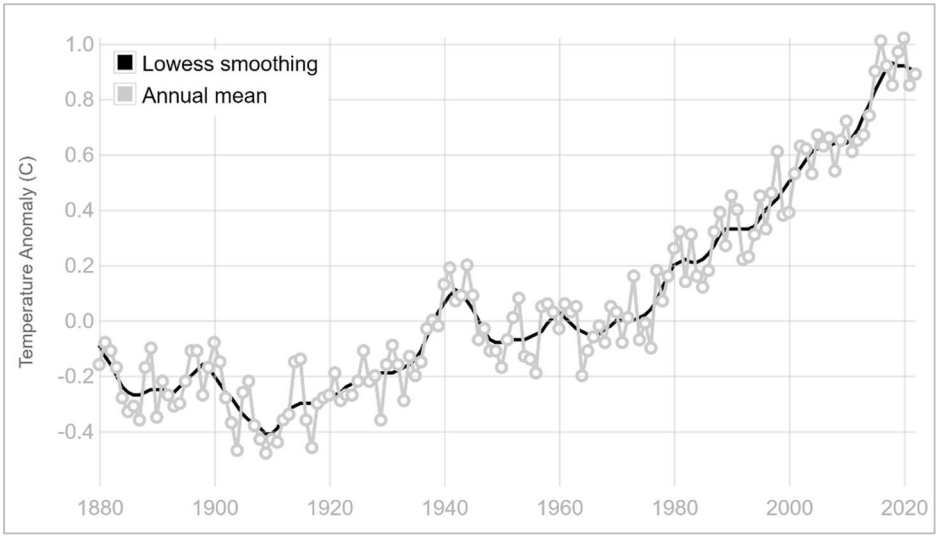
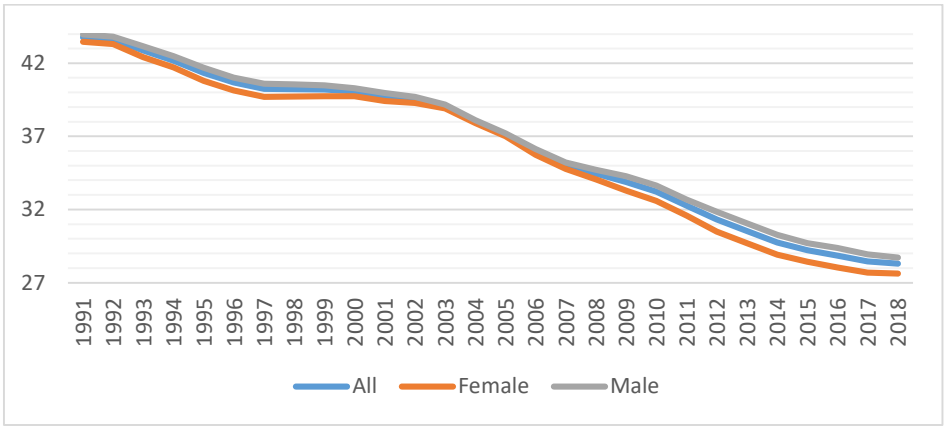


Figure 1. World Temperature According to 1901 – 2018

Figure 2 presents quite interesting information regarding the decreasing trend in the percentage of labor in the agricultural sector throughout the world. The data depicted shows that this decline occurs consistently in both male and female. This phenomenon provides a clear picture of the shift in the global employment structure, indicating that the agricultural sector is becoming less attractive as a career choice, especially among young workers.



Gambar 2. Persentase Tenaga Kerja Dunia Sektor Pertanian Menurut Jenis Kelamin Tahun 1991 – 2018

The decline in the percentage of the workforce in the agricultural sector can be interpreted as an indication that more people are switching to other employment sectors that are considered more attractive or financially profitable. This can be influenced by modernization and technological developments in the industrial and service sectors, which attract the attention of workers to look for opportunities outside agriculture.

The decline seen in both male and female suggests that this shift involves the entire spectrum of the workforce, regardless of gender. This reflects changes in people's mindset toward work in the agricultural sector, which may be considered more traditional and less up-to-date with global economic development trends.

Table 1. The Effect of Increasing Global Warming on the Percentage of World Agricultural Sector Workers (Male and Female)

Description	Increased Temperature				
	2013-2018 (5 Years)	**2008-2018 (10 Years)**	**1998-2018 (20 Years)**	**1968-2018 (50 Years)**	**1918-2018 (100 Years)**
Coefficient	-15.631***	-13.270***	-11.474***	-13.762***	-11.361***
Standard Error Coefficient	-2.996	-3.958	-2.190	-2.131	-2.248
Constant	30.455***	30.559***	28.983***	42.879***	40.803***
Standard Error Constant	-2.224	-2.512	-2.080	-3.687	-3.616
Observations	154	154	154	154	154
R-squared	0.132	0.066	0.126	0.150	0.118

Dependent variable: percentage of all agricultural sector workers (male and female)

Independent variable: increase in temperature over time

Robust standard errors in parentheses : *** p<0.01, ** p<0.05, * p<0.1

Table 1 provides comprehensive data and provides important insights into the impact of temperature changes on the labor structure in the agricultural sector, both in the short and long term. In general, the information contained in the table shows that changes in temperature have a significant negative influence on the composition of the workforce in the agricultural sector.

In the short term, unpredictable temperature fluctuations can create major challenges for agricultural workers. Extreme temperature increases or sudden changes in weather patterns can result in reduced productivity and even job loss. Weather uncertainty and extreme temperatures can place additional pressure on the agricultural sector, resulting in instability in employment.

In the long term, the impact of temperature changes on the agricultural sector could create a structural shift in the composition of the workforce. There may be a decline in interest among younger generations to engage in agriculture as a career due to the risks and uncertainties associated with climate change. In addition, changes in temperature can affect cropping patterns, farming methods, and the sustainability of natural resources, which directly impacts labor needs in this sector.

Table 2. The Effect of Increasing Global Warming on the Percentage of World Agricultural Sector Workers (Female)

Description	Increased Temperature				
	2013-2018 (5 Years)	2008-2018 (10 Years)	1998-2018 (20 Years)	1968-2018 (50 Years)	1918-2018 (100 Years)
Coefficient	-14.601***	-13.139***	-10.154***	-12.856***	-9.652***
Standard Error Coefficient	-3.286	-4.601	-2.463	-2.543	-2.671
Constant	29.291***	29.647***	27.768***	40.898***	37.705***
Standard Error Constant	-2.559	-2.936	-2.398	-4.296	-4.359
Observations	154	154	154	154	154
R-squared	0.088	0.050	0.076	0.101	0.066

Dependent variable: percentage of all agricultural sector workers (female)

Independent variable: increase in temperature over time

Robust standard errors in parentheses : *** p<0.01, ** p<0.05, * p<0.1

Table 2 and Table 3 provide further insight into the impact of temperature changes on the structure of the agricultural sector workforce, taking into account the gender breakdown of female and male. The data contained in the table reveals that increasing temperatures also have a significant negative role in the labor participation of female and male in the agricultural sector. This phenomenon reflects that climate change not only affects male but also specifically impacts female who work in agriculture.

By comparing the results between Table 2 and Table 3, it can be concluded that increasing temperatures have a deeper impact on male than female in the agricultural sector. This difference is caused by different work dynamics between male and female, as well as different roles in the agricultural supply chain. Factors such as the predominant type of work in the agricultural sector, access to resources, and social roles may contribute to differences in these impacts between genders.

The agricultural sector has long been the main arena for male labor participation, and this is largely due to the predominance of physical activity involved in this profession. Agriculture often requires great physical labor for tasks such as planting, harvesting, and maintaining crops. These activities may include lifting heavy loads, using agricultural equipment, and other activities that require substantial physical strength.

Male dominance in the agricultural sector can also be reflected in traditions and social norms that are deeply rooted in various societies. As time goes by, work in the agricultural sector is often considered work that is suitable for men, while women's roles are more often related to work in the domestic sector or other sectors. This view, which involves separating roles by gender, can reinforce stereotypes and inhibit women's participation in the agricultural sector.

Although male dominance in the agricultural sector is related to physical activity, it is important to recognize that the role of female in agriculture cannot be ignored. Female are often involved in agricultural work that requires special skills, such as processing and marketing agricultural products. Apart from that, female also have a vital role in financial management and resource management in the agricultural environment.

Table 3. The Effect of Increasing Global Warming on the Percentage of World Agricultural Sector Workers (Male)

Description	Increased Temperature				
	2013-2018 (5 Years)	2008-2018 (10 Years)	1998-2018 (20 Years)	1968-2018 (50 Years)	1918-2018 (100 Years)
Coefficient	-16.197***	-13.111***	-12.003***	-14.105***	-12.309***
Standard Error Coefficient	-2.906	-3.678	-2.116	-2.011	-2.104
Constant	31.314***	31.201***	29.818***	43.997***	42.737***
Standard Error Constant	-2.110	-2.334	-1.963	-3.487	-3.362
Observations	154	154	154	154	154
R-squared	0.156	0.071	0.152	0.175	0.153

Dependent variable: percentage of all agricultural sector workers (male)

Independent variable: increase in temperature over time

Robust standard errors in parentheses : *** p<0.01, ** p<0.05, * p<0.1

The importance of the agricultural sector in the context of sustainability and food security demands strong participation from the Government and the private sector. As one of the main pillars in providing food for the population, the agricultural sector requires special support and attention from the Government. Appropriate strategic steps and policies can ensure that this sector can contribute optimally to environmental sustainability and global food needs.

The Government has a key role in forming and implementing policies that support the sustainability of the agricultural sector. This involves developing regulations that promote sustainable farming practices, strengthening agricultural infrastructure, and providing incentives for farmers to adopt environmentally friendly technologies. In addition, there needs to be adequate financial support to facilitate investment in agricultural innovation and research to face the challenges of climate change and market dynamics.

The private sector also has a significant role in ensuring the sustainability of the agricultural sector. Involving agricultural companies, agribusinesses, and financial institutions can accelerate the adoption of new technologies and sustainable farming practices. Partnerships between the private sector and farmers can create efficient distribution channels and help increase farmers' access to markets, which in turn can increase their income.

In addition, technological innovation and research are key in advancing the sustainability of the agricultural sector. The Government and private sector need to work together to support research and development of agricultural technology that can increase productivity, resource efficiency, and crop resilience to climate change. Financial support, incentives, and facilitating collaboration between related parties can accelerate the adoption of innovation in the field.

Dengan peran serta aktif dari pemerintah dan sektor swasta, sektor pertanian dapat menjadi kekuatan driver of sustainability and global food security. Effective collaboration between these parties can create a supportive environment, encourage economic growth in rural areas, and provide solutions to the complex challenges faced by the agricultural sector. Sustainability in the agricultural sector is not only about achieving economically optimal results but also considering sustainable environmental and social impacts.

IV. Conclusion

Global warming is an important agenda that is a priority for all world leaders. All countries understand that the impact of global warming can disrupt various aspects of life. An important problem that can arise from global warming is the threat to the

agricultural sector. The sustainability of the agricultural sector has a strong correlation with people's interest in working as farmers. This research informs that increasing temperatures have a significant negative impact on the labor structure of the agricultural sector. These results indicate that people's enthusiasm for working in the agricultural sector is decreasing as global temperatures increase. Apart from that, the low public interest in the agricultural sector is due to several things, including economic uncertainty, physical and intensive working conditions, lack of access to technology and innovation, and level of education and knowledge. Therefore, the Government has a key role in forming and implementing policies that support the sustainability of the agricultural sector. Apart from that, it is necessary to involve agricultural companies, agribusiness, and financial institutions to accelerate the adoption of new technology and sustainable agricultural practices.

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