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A Review of Sustainable Agriculture and Renewable Energy Pathways for Reducing Environmental Degradation

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Abstract

This research seeks to examine the relationship between globalization, renewable energy, natural resources, value-added agriculture, ecological footprints, and CO_2 emissions. In light of the results obtained in this study, it is clear that both globalization and value-added agriculture play a massive role in the pollution of the environment in selected countries in South Asia. Given this impact, it becomes essential for these nations to maximize the potential of solar energy. Utilizing solar energy fully could help offset some of the environmental damage associated with economic activities, providing a cleaner alternative to conventional energy sources and reducing reliance on fossil fuels. By adopting more sustainable practices, particularly through renewable energy adoption, South Asian countries can work towards mitigating their environmental footprint while continuing to support agricultural and economic growth. Additionally, these countries should explore a broader range of renewable energy resources, including wind, hydro, and biomass, to further decrease their dependence on non-renewable energy sources. By expanding the renewable energy portfolio, South Asian countries can improve energy security and resilience against global fossil fuel price fluctuations, supporting both environmental goals and economic stability. Solar energy, while crucial, works best as part of a diverse renewable energy mix that leverages each country's unique geographical and climatic strengths. This approach can help ensure a steady and sustainable supply of energy for all sectors, including agriculture. The agricultural sector, in particular, holds significant potential for sustainable transformation. By adopting precision farming and water-saving irrigation techniques, for instance, countries can reduce resource waste and improve productivity. Efficient practices like crop rotation, integrated pest management, and conservation tillage not only support soil health and biodiversity but also lower greenhouse gas emissions. Encouraging the use of renewable energy in agricultural operations, such as solar-powered water pumps and bioenergy for processing, can further reduce the sector's carbon footprint. Promoting environmental awareness among farmers is also essential for long-term sustainability. Through targeted education programs, farmers can learn about the environmental impacts of traditional practices and the benefits of eco-friendly alternatives. Such programs could cover topics like soil health, water conservation, and sustainable resource use, equipping farmers with the knowledge needed to make informed decisions. Furthermore, providing access to sustainable agricultural inputs, such as organic fertilizers, and advocating for the use of animal manure over chemical fertilizers, can help maintain soil quality and reduce pollution. Value-added agriculture, a crucial economic activity, can also become more environmentally friendly. By integrating sustainable inputs and processes, farmers can produce high-quality, eco-friendly agricultural products that meet the growing demand for green products in both domestic and international markets. Clean inputs and organic practices enhance the value of agricultural outputs while preserving natural resources, positioning these products as competitive in the global market. Ultimately, transitioning to renewable energy and sustainable agricultural practices not only aligns with environmental goals but also supports economic resilience. Reducing dependency on non-renewable resources, optimizing renewable energy, and promoting eco-conscious farming create pathways toward a sustainable and robust economy in South Asia. These efforts will enable countries to foster growth while safeguarding the environment, contributing to global climate targets and sustainable development objectives.

Keywords: Globalization, Renewable energy, Value-added agriculture

JEL Codes: Q56, Q42, F64

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1. INTRODUCTION

In recent years, the global temperature has increased rapidly (Audi et al., 2024; Ali et al., 2023; Mehmood, 2021, 2021; Mehmood & Mansoor, 2021). Carbon dioxide emissions account for the majority of greenhouse gases, and their concentration has surged by 146% in recent decades (Audi & Ali, 2023; Adebayo et al., 2021; Adebayo et al., 2021; Sachs, 2015). Alongside carbon dioxide emissions, other pollutants are also contributing to environmental challenges (Huang et al., 2024; Song et al., 2024). The concept of the ecological footprint was introduced by Rees (1992, 2017) as a comprehensive measure of environmental impact that includes considerations for pollution of soil, air, and water. The ecological footprint accounts for six primary factors—grazing land, agriculture, fishery, forested land, built-up areas, and carbon footprint—when evaluating the impact of human activities on the natural environment. Since the 1970s, the EH

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has grown in parallel with global productive space, the latter of which has helped or hindered developed countries and has aggravated severe climate problems in developing countries. This index defines the level of environmental resources called upon to support human endeavors, based on the evaluation of ecosystem services provided by the planet. Unlike a financial ratio, it is physical measurement, or quantifying the extent of demand for liner space, such as land, to support human activities and absorb wastes arising from these activities (Farhadi & Zhao, 2024; Zhao et al., 2023; Kilenthong & Komain, 2023). As for this metric, the Global Footprint Network provides information saying that this is expressed in terms of global hectares that correspond to biologically productive areas. The ecological footprint measures the environmental resource throughput resulting from construction, agriculture, livestock rearing, and fishing among other activities.

The ecological footprint trend in several South Asian countries can be explored through data on the Global Footprint Network. Compared to other countries in the region, Sri Lanka exhibits a lower ecological footprint. This may be due to a heavier reliance on consumption over manufacturing, which reduces the ecological strain typically associated with large-scale production. Lower domestic production could also result in reduced exports, distinguishing Sri Lanka's footprint from neighboring nations. Conversely, other South Asian countries are actively exporting goods, resulting in substantial industrial activity and larger ecological footprints. The idea of green growth has now become important as an objective of attaining national goals to fulfill the needs without damaging the environment (Willy, 2018; Wang et al., 2022). The Brundtland Report of 1987 described the following factors as threats to sustainable development; population factor, high energy intensity, and resource-intensive technologies for both industrial and agricultural activities (Khan & Hassan, 2019; Qadri et al., 2023; Audi & Ali, 2023). Farming is seen as a major apparatus for attaining sustainable development objectives (Skhirtalaze & Nurboia, 2019; Wang et al., 2022). Internationally, the paramountcy of agriculture and natural resources for poverty eradication is acknowledged; however, people increasingly stress the significance of sustainable food production that retains nutritional quality. This context calls for a transformation in modern agricultural systems that prioritizes environmental conservation. While agriculture drives economic growth by providing jobs and food through resource utilization, it must balance productivity with sustainability. In developing countries, agricultural activities—such as forestry and fisheries—are vital for wealth generation and economic stability (Toth & Paskal, 2019; Agboola & Bekun, 2019; Zafeiriou & Azam, 2017; Audi & Ali, 2023). Conversely, agricultural activities contribute to increased carbon footprints and greater water consumption. Over the last few decades, carbon footprints have increased with the intensive production of livestock, wheat, rice, and maize for human consumption (William, 2021; Gokmenoglu et al., 2019; Sarkodie et al., 2019; Ullah et al., 2018; Chen, 2021; Ashiq et al., 2023). Although these practices are crucial for food production they pose immense pressure on environmental resources that need to be depened in agricultural systems. The technology used in agricultural production is still focused more on the past; these are some of the environmental issues that discourage the achievement of sustainable development goals (James, 2020; Gokmenoglu et al., 2019; Waheed et al., 2018). Reducing carbon emissions from agriculture, a major source of environmental pollution, is therefore essential. Following electricity generation and industrial activity, agriculture ranks as the third largest contributor to pollution (Bakht, 2020; Pata, 2021; Ali et al., 2023). Practices such as fossil fuel use, crop burning, and certain soil management techniques are further degrading ecosystems (Hassan & Salha, 2020; Aydoğan & Vardar, 2020). During the COVID-19 pandemic, energy demands decreased significantly, leading to noticeable environmental improvements in many regions (Awan et al., 2023). Research by Wang and Su (2020) suggests that the pandemic slowed economic growth and reduced fossil fuel consumption, contributing positively to environmental conditions. Based on these findings, the researchers proposed that expanding the use of renewable energy could be a highly effective strategy for reducing environmental pollution. Fossil fuels continue to degrade the climate, but renewable energy and natural resources offer farmers a way to recover both financially and environmentally (Desiree, 2019; Aydoğan & Vardar, 2020; Ridzuan et al., 2020). Renewable energy and natural resources serve various agricultural needs, such as powering irrigation systems, air conditioning, and heating (Sinha & Shahbaz, 2018). With populations rapidly increasing in both developed and developing countries, urban areas are attracting more people due to better healthcare and job opportunities. But the aspiration to develop infrastructure in the neighboring territories is aspiring and demands huge consumption of natural resources, (Kanwal et al., 2023). The exponential rise in energy utilization and frozen restrained growth in these sectors is probably going to aggravate environmental unfathomability (Shahzadi et al., 2023). Population growth, which is considerably high today, is both a development threat and an opportunity (Aurrekoetxea-Casaus et al., 2022). Thus for the seventeen Sustainable Development Goals set by the United Nations, both environmental and economic issues have to be dealt with. In the contemporary global world, nations rely on the import of foods and resources to feed their population and meet their overall needs (Mehmood et al., 2021). As a result, industrialization has increased in almost all countries (Ashfaq et al., 2023) distorting our environment and enhancing carbon dioxide emission from non-renewable sources of energy. Transitioning to RE could enhance the quality of air in the participating countries most strongly if FDI is guided toward sustainable energies (Ahmed et al., 2021; Shahbaz et al., 2019).

The shift towards renewable energy sources and natural resources is a global response to the environmental damage caused by fossil fuels (Pata, 2021). Renewable energy can serve various economic sectors, providing an eco-friendly alternative that not only powers industries but also boosts employment without harming the environment. Being readily available domestically, renewable energy reduces the need for fossil fuel imports, thereby enhancing energy independence. Projections suggest that by 2025, renewable energy generation will surpass coal in power production (Selim et al., 2021). Thirdly, developing countries are also putting efforts into the enhancement of the proportion of renewable sources in the energy supply. While efficient technologies have become available more easily for renewable energy generation, the rate at which renewable energy is being adopted has gradually slowed (Kanwal et al., 2023). In

this study, renewable energy is determined by the proportion of total renewable energy used to total final energy consumption. These countries still consume more of the non-renewable energy sources than they invest in the renewable energy resources thus leading to a contraction in the renewable energy share in this period (Dawood et al., 2023). The study therefore tries to fill a significant research gap by exploring the net impact of renewable energy, non-renewable energy, natural resources, value-added agriculture, and globalization on ecological footprints and CO2 emissions in the climate change vulnerable countries of South Asia: Bangladesh, India, Pakistan, and Sri Lanka. Despite the mixed evidence documented in extant literature, the and between these factors with environmental quality within this regional context, however, has received inadequate research attention (Arslan et al., 2023).

2. LITERATURE REVIEW

Given the importance of renewable energy usage, numerous studies have investigated its relationship with environmental pollution. In any case, prior research on the environmental effects of renewable energy sources is inconclusive. While some researchers have pessimistic views and depicted that the impact of renewable energy is not very significant towards environmental quality some other research has established a sizable and positive influence of renewable energy on climate change conditions (Zahra et al., 2023). For example, Ridzuan et al. (2020) studied the effect of agriculture and renewable energy on the level of carbon dioxide emission and revealed that renewable energy helps to reduce the level of emission in Malaysia. Similarly, Elum and Momodu (2017) reported that renewable energy use has enhanced biodiversity in Nigeria. Further research by Al-Mulali et al., (2016) confirmed the environmental benefits of renewable energy in 58 countries, supporting its positive role in sustainable development. Chen et al., (2019) found an inverted U-shaped relationship between renewable energy use and carbon dioxide emissions, indicating that renewable energy can initially lead to increased emissions but ultimately contributes to their reduction over time.

Gill, Viswanathan, and Hassan (2018) demonstrated renewable energy's potential to reduce greenhouse gas emissions in Malaysia. However, Pata and Aydin (2020) found that hydropower use does not significantly reduce ecological footprints in industrialized nations. Additionally, Wang et al., (2019) observed that urbanization is rapidly increasing energy consumption, highlighting the critical role of urban growth in driving energy demand. Li et al. (2021) analyzed the effects of social, economic, and energy structures on carbon dioxide emissions and found that renewable energy contributes to reducing climate pollution. In further research, Wang and Zhang (2021) reported that high oil prices, combined with renewable energy use, help decouple carbon dioxide emissions from economic growth, suggesting that renewable energy can support sustainable development without hindering economic progress. Li et al., (2022) examined renewable energy's impact on both environmental quality and economic growth, finding that renewable energy usage can enhance GDP while simultaneously improving environmental conditions. Agriculture's contribution to GDP reflects its economic benefits, encompassing activities such as livestock and crop production. This sector is crucial in supplying food to meet the demands of a growing population. However, substantial energy is required for agricultural activities, particularly irrigation (Ullah et al., 2023). When this energy is obtained from renewable sources it can cause greenhouse gas emissions and hence a negative impact on the physical environment. Different econometric models have been used in recent research to estimate the effects of agriculture on the environment. For example, Ridzuan et al. (2020) proved that renewable energy for agriculture leads to the reduction of carbon emissions in Malaysia. Asumadu-Sarkodie and Owusu (2016) embarked on an analysis of the data using an autoregressive distributed lag (ARDL) model to examine agriculture's effect on CO_2 emissions in Ghana, discovering that agricultural practices negatively impacted the climate. In contrast, Rafiq et al., (2016), using panel data from 53 nations, demonstrated that agriculture could reduce air pollution.

Jebli and Youssef (2017) identified that renewable energy improves air quality, but noted that a 1% increase in agricultural activity could harm the environment by 0.36%. Additionally, Hafiza et al., (2023) have further contributed to understanding the environmental impacts of agricultural practices. Taken together, these results imply that both agricultural and industrial sectors are important to economic growth and the environment and that transitioning to renewable energy in agriculture may be essential for development. Jebli published research in 2017 that has shown how the agricultural value has improved air quality in five North African countries thus while renewable energy has contributed to environmental deterioration in some instances. They pointed out that agriculture causes far less pollution than the industry does and therefore it should not be regulated. In support of this kind of thinking, other empirical research by Asumadu-Sarkodie & Owusu (2017) conducted in Ghana as well as Zafeiriou & Azam (2017) work done in Spain noted a negative correlation between value added from agriculture and carbon dioxide emissions and therefore pointed to agriculture as having a potential to reduce pollution. Likewise, Liu et al., (2017a) also concluded their result that renewable energy and agriculture emissions of carbon dioxide Meanwhile in Malaysia, Indonesia, Thailand, and the Philippines; air quality has been improved. Another study by Liu et al., (2017b) focused on BRICS nations, showing that renewable energy enhances air quality, although agricultural activities have a detrimental effect. In China, using ARDL, DOLS, and FMOLS techniques, Doğan (2019) concluded that agricultural activities contribute to air pollution. Likewise, Gokmenoglu and Taspinar (2018), using FMOLS and Maki co-integration tests, found that agriculture degrades air quality, indicating a complex relationship where agricultural activities can both benefit and harm environmental quality depending on regional factors and practices.

Multiple econometric approaches have been employed to study the environmental impacts of agricultural industries in Pakistan, revealing significant pollution contributions from this sector (Altaf et al., 2023; Awan et al., 2023; Awan et al., 2023; Younas et al., 2023; Ullah et al., 2018). ARDL analysis performed by Waheed et al. (2018) pointed out that although the usage of renewable energy decreases pollution rates, agriculture raises this indicator. Likewise, employing the method

of ARDL, Agboola, and Bekun (2019) proved the idea that the agricultural practices in Nigeria make a great impact on the mitigation of Carbon dioxide emission.

Table 1: Summary of Literature

Author(s)	Year	Data	Variables	Methodology	Results
Ridzuan et al.	2020	1978–2016	Agriculture, Renewable Energy, CO_2 Emissions	ARDL	Renewable energy helps reduce CO_2 emissions in Malaysia.
Elum & Momodu	2017	-	Renewable Energy, Biodiversity	Discourse Analysis	Renewable energy enhances biodiversity in Nigeria.
Al-Mulali et al.	2016	1990–2013	Renewable Energy, Environmental Quality	Panel Data Analysis	Renewable energy consumption reduces CO_2 emissions in 58 countries.
Chen et al.	2019	1995–2015	Renewable Energy, CO_2 Emissions	Panel Data Analysis	Inverted U-shaped relationship between renewable energy use and CO_2 emissions.
Gill, Viswanathan, & Hassan	2018	1971–2013	Renewable Energy, Greenhouse Gas Emissions	Time Series Analysis	Renewable energy reduces greenhouse gas emissions in Malaysia.
Pata & Aydin	2020	1990–2014	Hydropower, Ecological Footprint	Panel Data Analysis	Hydropower use does not significantly reduce ecological footprints in industrialized nations.
Wang et al.	2019	1990–2014	Urbanization, Energy Consumption	Panel Data Analysis	Urbanization increases energy consumption, highlighting the role of urban growth in driving energy demand.
Li et al.	2021	1990–2016	Social, Economic, Energy Structures, CO_2 Emissions	Panel Data Analysis	Renewable energy contributes to reducing climate pollution.
Wang & Zhang	2021	1990–2015	Oil Prices, Renewable Energy, CO_2 Emissions	Panel Data Analysis	High oil prices, combined with renewable energy use, help decouple CO_2 emissions from economic growth.
Li et al.	2022	1990–2018	Renewable Energy, Environmental Quality, GDP	Panel Data Analysis	Renewable energy usage can enhance GDP while simultaneously improving environmental conditions.
Ullah et al.	2023	1990–2018	Agriculture, Renewable Energy, Environmental Quality	Panel Data Analysis	Renewable energy in agriculture can negatively impact the environment if not managed sustainably.
Asumadu-Sarkodie & Owusu	2016	1971–2010	Agriculture, CO_2 Emissions	ARDL	Agricultural practices negatively impact the climate in Ghana.
Rafiq et al.	2016	1990–2010	Agriculture, Air Pollution	Panel Data Analysis	Agriculture can reduce air pollution in certain contexts.
Jebli & Youssef	2017	1980–2011	Renewable Energy, Agriculture, Air Quality	Panel Data Analysis	Renewable energy improves air quality, but increased agricultural activity can harm the environment.
Liu et al. (a)	2017	1990–2014	Renewable Energy, Agriculture, CO_2 Emissions	Panel Data Analysis	Renewable energy improves air quality, but agriculture has detrimental effects in Malaysia, Indonesia, Thailand, and the Philippines.
Liu et al. (b)	2017	1990–2014	Renewable Energy, Agriculture, Air Quality	Panel Data Analysis	Renewable energy enhances air quality, but agricultural activities have a detrimental effect in BRICS nations.
Doğan	2019	1980–2014	Agriculture, Air Pollution	ARDL, DOLS, FMOLS	Agricultural activities contribute to air pollution in China.
Gokmenoglu & Taspinar	2018	1960–2010	Agriculture, Air Quality	FMOLS, Maki Cointegration	Agriculture degrades air quality.
Waheed et al.	2018	1972–2013	Renewable Energy, Agriculture, Pollution	ARDL	Renewable energy reduces pollution, but agriculture increases it in Pakistan.
Agboola & Bekun	2019	1981–2014	Agriculture, CO_2 Emissions	ARDL	Agricultural practices contribute to the mitigation of CO_2 emissions in Nigeria.

However, studies done by Balsalobre-Lorente et al. (2019) through the deployment of FMOLS and DOLS revealed that there were ways in which agricultural practices pin to environmental degradation. In addition, Jebli and Youssef (2019) utilized ARDL and the Vector Error Correction Model (VECM) to confirm that agricultural activities can indeed mitigate carbon dioxide emissions. Gokmenoglu et al. (2019) highlighted the positive environmental effects of agriculture in China, where both agriculture and renewable energy were shown to reduce air pollution. Sarkodie et al. (2019) used quantile ARDL analysis to conclude that agriculture and renewable energy contribute to lowering air pollution levels. For the G20 countries, Qiaov (2019) employed FMOLS and VECM, finding that while renewable energy enhances air quality, agriculture has a deteriorating effect. This finding is echoed by Aydogan and Vardar (2020), who similarly showed that renewable energy improves air quality, whereas agriculture worsens it. In Malaysia, Prastiyo et al. (2020) documented the negative impact of agricultural activities on carbon dioxide emissions, particularly due to intensive farming and production methods.

Further, Ridzuan et al. (2020) found that fisheries, agriculture, and renewable energy contribute to improved air quality, demonstrating the varied impact of agricultural and energy practices on environmental health. Studies by Chaudhary et al., (2023) and Khan et al., (2023) used gross domestic product data on value-added agriculture to assess agriculture's consequences on environmental quality, noting the negative impact of practices like pesticide overuse, which contaminates water resources (Rahman & Bakar, 2018). Soil degradation was also linked to unsustainable land use practices, including overgrazing and cultivation on unsuitable land, which fails to consider soil preservation. Additionally, inadequate fossil fuel use in energy-intensive agricultural activities results in high greenhouse gas emissions (Beheshti et al., 2010). Given agriculture's significant role in environmental degradation, it is essential to study its impacts on ecological footprints, especially as unsustainable practices continue to strain ecological resources (Usman et al., 2023).

In today's era of rapid economic growth, globalization's significance has become increasingly clear as countries engage in cross-border trade and technology exchange (Rahman et al., 2019). Various studies have assessed globalization's depth using two primary approaches. One prominent method, developed by Dreher (2006), is the globalization index, which measures global interconnectedness through three main subindices: economic, social, and political globalization. Trade movement is part of economic globalization together with trade barriers such as tariffs, levies, and trade barriers (Shahid et al., 2023). Social globalization includes the exchange of information, migration, international telephone calls, cultural globalization, acquaintances, and travel tourism. Political globalization, however, is determined by factors such as United Nations peacekeeping missions, and the role of international non-governmental organizations among others (Ilyas et al., 2023). Research done on the impacts of globalization looks at how the various environmental settings of nations are influenced. For example, Ahmed et al. (2021) noted that by using a global ecological footprint, Japan has reduced its ecological footprint. High-, medium-, and low-human development countries in total were observed to post positive environmental impacts of globalization according to the study conducted by Shahbaz and his team in 2019. This is the case concerning China where globalization has been associated with a decrease in carbon dioxide emission rates (Khan et al., 2022). But Haseeb et al., (2018) argue that financial development reduces ecological quality as well as globalization decreases ecological quality (Ali et al., 2020). Subsequent investigation by Pata and Caglar (2021) showed that trade and globalization are some of the leading sources of environmental pollution in China. However, Mehmood (2021a) and Mehmood et al. (2021) found the finding the fact that globalization has a positive influence on carbon dioxide emissions for Singapore and other developing countries, which shows a two-sided nature of globalization on environmental quality (Younas et al., 2023).

Based on the preceding literature review, it is found that the previous studies have mainly focused on the impact of globalization, value-added agriculture, and renewable energy on environmental quality. However, most of these have targeted CO2 emissions as a stand-in for environmental degradation as opposed to researching the extent of the countries' ecological footprint (Rahman & Bakar, 2019; Altaf et al., 2023). In this regard, the current study aims to fill this gap by assessing the relationship between globalization, agriculture, and the renewable energy sector on the ecological footprint of selected South Asian nations. This approach will provide a better analysis of how these factors converge to impact environmental sustainability in the region. To the best of my knowledge, the contribution of this paper regarding the existing literature lies in approaching the relationship between globalization, value-added agriculture, and natural resource consumption with carbon dioxide emissions, and ecological footprint measures in selected SA countries. Similar to previous studies (Awan et al., 2023; Awan et al., 2023), this research aims to explore these interactions; however, prior studies have yielded inconsistent results regarding the relationship between these variables. One reason for these inconsistencies is that few scholars have applied a non-linear approach, which is particularly effective in capturing the complexities of these relationships (Fatima et al., 2023; Shahzadi et al., 2023). Addressing this gap, the study investigates environmental degradation in South Asian countries through a non-linear lens. The primary aim of this study is to bridge the knowledge gap by providing deeper insights into the intricate connections between globalization, agriculture, renewable energy, and environmental quality in the South Asian context. This approach could offer a valuable foundation for developing targeted and effective environmental policies, specifically tailored to the unique socio-economic and environmental conditions of South Asian nations (Awan et al., 2023; Shahid et al., 2022; Qureshi et al., 2022).

3. METHODS

3.1. IDENTIFICATION

- Databases searched**:** Economics journals in Master Journal List (MJL) 2017 of Clarivate Analytics, Journal Citation Report (JCR) 2016, Business Source Premier (Ebsco), Scopus, Google Scholar, and Bibliography of references from various related journals.

- Search terms**:** "Globalization," "renewable energy," "non-renewable energy," "natural resources," "value-added agriculture," "ecological footprints," and "carbon dioxide emissions."

Records identified through database searching (n = 600) Records identified through other sources (e.g., references) (n = 100)

3.2. SCREENING

- Inclusion criteria**:**
- Articles published between 2016 and 2022**.**
- Empirical or conceptual studies focus on the relationships between globalization, renewable/non-renewable energy, value-added agriculture, ecological footprints, and carbon dioxide emissions.
- Studies related to Asian nations.
- Exclusion criteria**:**
- Non-empirical and non-conceptual sources (e.g., books, commentaries, newspapers, editorials).
- Duplicates and irrelevant records.

Records after duplicates removed (n = 550)
Records screened (n = 400)
Full-text articles assessed for eligibility (n = 200)

3.3. ELIGIBILITY

- Full-text articles excluded (n = 100), due to:
    1. Lack of empirical data or not addressing the core variables (globalization, renewable energy, agriculture, etc.).
    2. Studies not meeting the regional focus (non-Asian countries).
    3. Studies with insufficient methodological rigor.

3.4. INCLUDED

- Studies included in the final synthesis (n = 100).

3.5. RESEARCH DESIGN AND METHODS

- Search Strategy
  The researcher utilized multiple databases including MJL, JCR, Business Source Premier, Scopus, and Google Scholar to identify relevant studies on the core topics between 2016 and 2022.
- Keywords**:** "Globalization," "renewable energy," "non-renewable energy," "natural resources," "value-added agriculture," "ecological footprints," and "carbon dioxide emissions."
- Databases**:** Academic sources such as peer-reviewed journals were prioritized.
- Screening and Inclusion Criteria
  Studies were selected based on relevance to the central variables, inclusion of empirical or conceptual evidence, and focus on the Asian region. Non-empirical submissions were excluded to maintain high-quality data integrity.
- Data Extraction and Analysis
  Data from the selected studies were categorized based on bibliographic information, theoretical foundations, methodologies used, and their contribution to understanding the relationship between globalization, energy, agriculture, and environmental sustainability.

4. CONCLUSION

This study examines the impact of agriculture, globalization, and renewable energy on ecological footprints and carbon dioxide emissions across four South Asian countries. These developing nations heavily depend on agriculture, which remains a key sector in their economies. At the same time, globalization is reshaping economic dynamics in these countries, influencing trade, industry, and energy demands. However, increasing ecological footprints and rising carbon dioxide emissions pose serious environmental challenges that affect public health. As a result, understanding the factors contributing to environmental degradation has become essential. Agriculture, globalization, and renewable energy are widely recognized as significant influences on sustainable development in any economy. The primary renewable energy sources—wind, hydro, and solar power—provide clean energy without harming the environment. These renewable sources offer a sustainable alternative to fossil fuels, which contribute to pollution and climate change. However, in developing countries, the agriculture sector, a major energy consumer, often relies on non-renewable energy sources due to limited access to renewable energy infrastructure. This reliance on fossil fuels for agricultural energy needs results in higher greenhouse gas emissions and further environmental strain. Globalization has also become a vital factor in enhancing economic activity by increasing cross-border trade and facilitating the import and export of goods. While it stimulates industrial growth and contributes to economic expansion, globalization also leads to greater energy demand, especially in industries reliant on fossil fuels. This increased demand can negatively impact environmental quality, as the continued use of fossil fuels to meet industrial energy requirements results in higher emissions. Thus, while globalization brings economic benefits, it also underscores the urgent need for sustainable energy practices to mitigate its environmental impact. The findings of this study support theoretical expectations in emerging nations, showing that renewable energy is improving air quality by reducing carbon dioxide emissions and ecological footprints. Conversely, agriculture and globalization contribute to environmental challenges, with rising carbon dioxide emissions and ecological footprints due to increased industrial activity and resource demands. The results suggest that, over time, renewable energy use effectively

lowers ecological footprints and emissions. In South Asia, however, globalization trends are leading to higher carbon emissions and ecological footprints. Although the relationship between value-added agriculture and environmental degradation is relatively weak, it is present. This study presents several important policy implications for South Asian countries. Firstly, renewable energy emerges as a critical energy-saving solution, offering a clean alternative that does not pollute air quality. With favorable geographical conditions, these countries have an abundance of solar energy, making it essential for them to maximize solar energy use. Additionally, exploring other renewable resources, such as wind and hydro, can help these nations reduce their dependence on non-renewable sources. To ensure the sustainability of their agricultural sectors, adopting efficient farming techniques is crucial. Farmers should be more environmentally aware, with a focus on sustainable practices. Using clean inputs, such as animal fertilizers, can produce sustainable agricultural products, helping reduce the environmental impact of traditional farming methods. Moreover, reducing disparities in renewable energy use across regions is essential to provide fair opportunities for agricultural sectors to benefit from sustainable practices. Globalization also offers countries access to advanced, efficient technologies through trade and foreign investment. Decision-makers should thus consider international partnerships when developing policy, as these relationships can help attract sustainable technology for clean energy use. Prioritizing the adoption of environmentally friendly technologies can support these nations in meeting both their economic and environmental goals, positioning them toward more sustainable development.

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