

Addressing the Global Food Security Crisis and Energy Shortages: Innovative Solutions and Policy Interventions for Sustainable Development

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Abstract

Food security crises and energy shortages are becoming increasingly pressing global challenges, exacerbated by rapid population growth and inexorable climate change. Land use conflicts, inefficiencies in food and energy systems, and impacts on biodiversity require breakthrough approaches for sustainable solutions. This research aims to investigate innovative solutions and policy interventions that can support sustainable development in overcoming this crisis. The research was conducted through a descriptive qualitative approach, with data obtained from relevant previous studies, and data analysis was carried out to identify patterns and potential solutions. The results of this research find that agricultural and energy policy reform, increased investment in clean technologies, strong international cooperation, and public education and awareness are the keys to achieving food and energy security. Innovations in sustainable agricultural technology and the development of renewable energy have proven vital in reducing dependence on fossil fuels and minimizing environmental impacts. Efficient management of water resources and food and energy systems that operate in a circular model is also important to maximize efficiency and reduce waste. Through the implementation of these strategies, global society can move towards more sustainable development, ensuring access to food and energy for all.

Keywords: *Food Security, Energy Shortage, Sustainable Development, Innovative Solutions, Policy Intervention.*



A. INTRODUCTION

The world is currently at a critical point in facing two major, interrelated challenges: the food security crisis and energy shortages. This crisis not only has a direct impact on the welfare and security of the global community but also threatens the achievement of internationally agreed sustainable development goals. Factors such as rapid population growth, climate change, inefficient land use, and high and unsustainable energy consumption, have placed tremendous pressure on the world's food and energy systems (Barrett, 2021).

Continuous population growth causes an increase in demand for food and energy. This, combined with limitations on existing natural resources, creates major

challenges in meeting basic human needs. Additionally, climate change is negatively impacting global food production through changing weather patterns, leading to increasingly frequent droughts, floods, and other extreme weather events. This condition not only reduces the amount of food production but also disrupts food distribution to various parts of the world, worsening the food security situation (Imasiku & Ntagwirumugura, 2020).

Energy shortage is another global problem that is closely related to the food security crisis. Energy is an important component in the food production and distribution process. The agricultural sector requires energy for operating agricultural machines, processing, packaging, and transporting food (Pawlak & Kołodziejczak, 2020). However, heavy dependence on fossil fuels and inefficiencies in energy use have led to sustainability and energy security issues. In addition, climate change accelerated by greenhouse gas emissions from the energy sector also affects the availability of natural resources, including water and land needed for food production (Olujobi et al., 2023).

In a global context, the imbalance between the need for and availability of food and energy has led to an increase in food and energy prices, which harms accessibility and affordability for many groups of people, especially in developing countries. This situation is exacerbated by political and economic instability in some regions, which hampers efforts to develop infrastructure and invest in clean and efficient technologies (Molajou et al., 2021).

This crisis of food security and energy shortages requires innovative solutions and comprehensive policy interventions to ensure sustainable development. The policies and strategies adopted must not only focus on increasing production, but also more efficient resource management, reducing waste, and implementing environmentally friendly technologies. This requires cross-sectoral and cross-country collaboration, as well as the involvement of various stakeholders, including government, the private sector, the scientific community, and civil society, to jointly address these challenges and ensure the well-being of current and future generations.

B. LITERATURE REVIEW

1. Food Security

According to Law Number 7 of 1996, food is defined as any substance originating from biological and aquatic sources, regardless of whether it is processed or unprocessed, that is meant for human consumption as food or beverage. This includes food additives, raw food materials, and other substances utilized in the preparation, processing, and/or production of food or beverages (Machín et al., 2020).

Law Number 7 of 1996 defines food security as the state of a household's food needs being met, evident in the sufficient availability of food, both in terms of quantity and quality, that is safe, distributed fairly, and accessible financially (Yusri et al., 2021). Several core principles are associated with this concept of food security, directly or indirectly, and must be considered:

- a. The household represents the critical focus for addressing the food requirements on national, community, and individual levels.
- b. It is the government's responsibility to ensure every citizen within the most basic societal units has access to the food necessary for survival.
- c. The concept of food availability encompasses both the adequate quantity of food (food sufficiency) and the assurance of its quality (food quality).
- d. The volume of food available is influenced by food production activities or processes, which include producing, preparing, processing, creating, preserving, packaging, repackaging, and/or altering the food's form.
- e. Food quality is assessed based on criteria for food safety, nutritional value, and commercial standards for ingredients used in food and beverages.
- f. Food safety involves the measures and actions necessary to protect food from potential biological, chemical, and other risks that could disrupt, harm, or endanger human health.
- g. Food equity is a crucial aspect of social justice in food, largely measured by the state's success in ensuring food rights for its citizens through the distribution system it establishes. Food equity demands that the national food system guarantees every household's right to food without discrimination.
- h. Food affordability is about the equal opportunity and ability of each household to secure their right to food. It's a critical element of food justice, highlighting the importance of equitable access and control over food resources (Zhuang et al., 2022).

The concept of food security, as previously discussed, can be distilled into the following key components:

- a. Food Availability: Ensuring a sufficient supply of food (food sufficiency).
- b. Food Safety: Guaranteeing food is free from biological, chemical, and other hazards that could compromise human health, along with assured food quality, meaning it satisfies nutritional requirements and meets standards for food and beverage ingredients.
- c. Food Equity: Implementing a food distribution system that ensures consistent and equitable access to food.
- d. Food Affordability: Facilitating household access to food at prices that are reasonable and within their financial reach (Clapp et al., 2022).

2. Sustainable Development

The idea of sustainable development gained prominence following its endorsement by the Brundtland Commission, led by Gro Harlem Brundtland, the Norwegian Prime Minister, from October 1984 to March 1987. This initiative culminated in the publication of "Our Common Future" by the World Commission on Environment and Development (WECD) in 1987, a seminal work that played a pivotal role in advancing the concept (Bergquist & David, 2023).

In the 20th century, two significant shifts occurred regarding the environment's role in economic and social progress. The first shift happened during the 1960s and

1970s, marking a period when the prevailing thought recognized a conflict between the goals of growth and the conservation of natural resources and the environment. It was observed that development efforts aimed at enhancing human welfare invariably led to the exploitation of natural resources and environmental degradation (Yeny et al., 2022). During this era, Meadows and Meadows, associated with the Club of Rome, authored "The Limits to Growth". This publication argued that without a reduction in societal consumption levels, the world would face collapse within a century due to the exhaustion of natural resources and severe pollution and environmental damage (Herrington, 2021).

The concept of sustainable development, defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs, was brought to the forefront during an international gathering in Norway. This pivotal meeting, overseen by Norwegian Prime Minister Gro Harlem Brundtland in 1987, played a crucial role in shaping the modern understanding of sustainability (Hummels & Argyrou, 2021).

During this period, it was as though a second revolution in the realm of national development was taking place, which posited that economic development need not harm the environment. Instead, it suggested that economic and environmental development could work in tandem, paving the way for true and sustainable prosperity (Dogaru, 2020). This perspective argued that economic growth could lead to increased national income, providing countries with the resources needed to protect and sustain their environments from degradation. Conversely, maintaining healthy environmental conditions wouldn't drain development funds but would support the sustenance of human life and other living beings, thus creating a symbiotic relationship between economic growth and environmental preservation (Fernandes et al., 2021).

The foundation of sustainable development rests on three main pillars: economic, social, and environmental sustainability. These elements must progress in harmony to avoid the pitfalls of traditional development approaches, which prioritize economic growth at the expense of social and environmental considerations. The outcome of such conventional development practices has led to a stark disparity in the distribution of wealth, where 20% of the population in developed nations controls 80% of global income, leaving the 80% of the population in developing countries with only 20% of the world's income (Ranjbari et al., 2021). Consequently, this model of development faces obstacles related to social issues (such as health, education, and poverty) and the depletion of natural resources (including fossil fuels and non-renewable coal), alongside deteriorating environmental conditions marked by pollution of air, water, rivers, and lakes. This scenario also encompasses challenges like water scarcity during dry periods and flooding in the rainy season, affecting many regions in Indonesia, other developing nations, and even developed countries (Xu & Zhao, 2023).

3. Policy Intervention

Policy intervention is a strategic approach implemented by the government or authorized institutions to face and resolve various issues and challenges in society. This concept involves the development, implementation, and evaluation of policies that aim to modify or influence behavior, social structures, or economic and environmental conditions to achieve certain predetermined goals. Through policy interventions, the government seeks to direct society towards better conditions, overcome injustice, and respond to growing public needs (Khan et al., 2020).

In the process, policy interventions require in-depth analysis and a comprehensive understanding of social dynamics and factors that influence certain issues. This approach must be inclusive and participatory, incorporating perspectives from various stakeholders, including civil society, the private sector, and academia (Rodríguez-Pose, 2020). This is important to ensure that the policies produced are not only effective in overcoming the problems faced but are also fair and acceptable to various levels of society. Thus, policy intervention becomes a collaborative process that requires ongoing dialogue and consultation (Yifu & Wang, 2022).

Implementing policy interventions is often faced with various challenges, ranging from limited resources, and resistance from certain groups, to difficulties in measuring the immediate and long-term impact of policies. Therefore, governments need to adopt a flexible and adaptive approach, ready to revise and adjust policies based on feedback and evaluation results. This adaptive approach allows governments to respond to rapidly changing social dynamics and ensures that policies remain relevant and effective in achieving desired goals (Knapp & Wong, 2020).

In addition, the success of policy interventions also depends on the ability to integrate innovation and best practices from various fields. New technologies, big data, and advanced analytics can be leveraged to increase understanding of complex issues, improve decision-making processes, and increase the effectiveness of policy implementation. Thus, policy interventions not only aim to overcome current problems but also prepare society to face future challenges in a more resilient and sustainable way (Bradley et al., 2021).

C. METHOD

This research aims to investigate ways to overcome the global food security crisis and energy shortage through innovative solutions and policy interventions for sustainable development. The method used in this research is a descriptive qualitative approach, which allows researchers to understand phenomena in a broader context through in-depth data collection and analysis. This approach was chosen because of its ability to capture the complexity of the issues faced in achieving food and energy security and sustainable development, by utilizing various relevant research results and previous studies. After the data is collected, the data analysis process will be carried out to extract findings that are significant and relevant to the research objectives. This analysis will include filtering the data to determine its relevance, categorizing the data based on key emerging themes, and interpreting the data to

produce a deeper understanding of the dynamics of the food and energy security crisis and applicable solutions. Through this approach, research is expected to provide new insights and valuable policy recommendations to effectively address this global challenge, with an emphasis on innovative solutions and policy interventions that support sustainable development.

D. RESULT AND DISCUSSION

1. Dynamics of Food Security Crisis and Energy Shortages

In recent decades, the world has witnessed rapid global population growth, which has significantly increased the demand for food and energy resources. This population growth, which is expected to continue to increase in the coming years, has placed unprecedented pressure on our food and energy systems. With more mouths to feed and increasing energy requirements, the challenge of meeting this demand is becoming increasingly complex. This population growth not only increases food and energy consumption but also expands the need for land for housing, agriculture, and energy development, often triggering significant land use conflicts (Tian et al., 2021).

Climate change, accelerated by human activities, adds complexity to this challenge. The impact of climate change on food production and energy availability is significant, with the frequency of natural disasters such as droughts, floods, and storms increasing, increasingly affecting energy infrastructure and agricultural land. These changing weather patterns not only threaten food production through reduced crop yields and damage to agricultural land but also pose risks to energy supplies, especially in areas that depend on natural resources such as water and biomass for energy. Natural disasters can damage energy infrastructure, such as power plants, transmission networks, and distribution lines, disrupting vital energy supplies for agricultural and food processing operations.

Land use conflicts, exacerbated by population growth and climate change, pose significant challenges in meeting food and energy needs. Arable land and access to water are becoming increasingly scarce, with land often having to be divided between needs for agriculture, housing, and energy development. This creates a dilemma, where increasing land for agriculture can reduce land available for energy development and vice versa. Inefficient land use, whether for agriculture or energy development, can result in reduced productivity and environmental damage, further exacerbating the food and energy security crisis.

Inefficiencies in food and energy systems add to the complexity of the problem. Food loss and waste is a significant global problem, with the majority of food produced never consumed by humans or lost before reaching the final consumer. This is not only a waste of valuable resources but also adds to greenhouse gas emissions that contribute to climate change. Meanwhile, inefficiencies in energy production, distribution, and consumption result in excessive resource use and unnecessary emissions. Energy systems that rely on fossil fuels and outdated technologies are often inefficient and unsustainable, increasing the burden on our environment and exacerbating climate change.

Addressing these dynamics of food security crises and energy shortages requires a comprehensive and coordinated approach that considers all aspects of the problem – from population growth and climate change to land use and system inefficiencies. We must seek innovative solutions that not only increase food and energy production but also promote efficient and sustainable use of resources to ensure that we can meet the needs of a growing global population without destroying our planet. This is a huge challenge, but also an opportunity to implement meaningful change toward a more sustainable future.

2. Challenges in Achieving Sustainable Development

Achieving sustainable development is faced with several significant challenges that are complex and interrelated, which require comprehensive and coordinated solutions to be overcome. One of the main challenges is limited natural resources, which are becoming increasingly critical amidst global population growth and increased consumption. Natural resources, such as water, land, and fossil fuels, are not only limited but also experiencing rapid depletion due to overexploitation. This depletion has a direct impact on food and energy security, limiting our ability to produce enough food and energy to meet the needs of a growing population. Furthermore, unsustainable exploitation of natural resources contributes to environmental degradation, which worsens conditions for sustainable food and energy production (Olawuyi, 2020).

Gaps in access and affordability are other challenges that hinder the achievement of sustainable development. Despite technological advances and economic growth, there are still significant disparities in access to quality and affordable food and energy among different groups of people and countries. This is often linked to economic and social inequality, with poorer societies and developing countries facing greater difficulties in accessing the resources necessary for daily life. This gap not only raises ethical but also practical problems, because unequal access can cause social instability and hinder economic growth.

Existing policies and regulations are often insufficient to overcome challenges in achieving food and energy security. Although many countries have introduced policies and regulations to promote more sustainable and efficient use of resources, implementation and enforcement of these policies are often challenging. This can be caused by a variety of factors, including lack of resources, lack of expertise, corruption, and resistance from influential interest groups. Additionally, policies often have to balance economic growth and environmental protection, which can be an area of conflict. Without effective and well-enforced policies and regulations, efforts to promote sustainable development can be hampered.

Finally, pressure on biodiversity and ecosystems is another important challenge in achieving sustainable development. Agricultural activities and energy production, especially when carried out without considering environmental impacts, can cause damage to local biodiversity and ecosystems. Habitat loss, pollution, and the use of pesticides and chemical fertilizers can reduce species diversity and damage

important ecosystem functions, such as carbon sequestration, water filtration, and pollination. Damage to biodiversity and ecosystems not only has direct consequences for the environment but also for the economy and human well-being, given our deep dependence on ecosystem services.

Facing these challenges requires an integrated approach that considers all dimensions of sustainable development: economic, social, and environmental. This involves investing in clean technologies, developing innovative and equitable policies, and increasing public awareness and participation in conservation efforts. Achieving sustainable development also requires strong international cooperation, given the global nature of many of these challenges. Through joint efforts and commitment to common goals, we can overcome these challenges and build a more sustainable future for future generations.

3. Innovative Solutions for Food and Energy Security

In overcoming the food and energy security challenges we face today, innovative solutions hold the key to creating a more sustainable and efficient system. One promising area is the development and application of sustainable agricultural technology. Innovations in this field, such as precision agriculture, hydroponics, and aquaponics, enable more efficient food production by minimizing the use of natural resources such as water and land, as well as reducing the use of pesticides and chemical fertilizers that can damage the environment (Mishra et al., 2021). Precision farming technology, for example, uses data and advanced algorithms to optimize watering, fertilization, and other treatments, so that every part of the farm gets exactly what it needs for optimal plant growth. This not only increases productivity per hectare but also reduces the environmental impact of agricultural activities.

The development of renewable energy is also a crucial component in our efforts to achieve sustainable energy security. Energy sources such as solar, wind, hydro, and biomass offer environmentally friendly and renewable alternatives to fossil fuels, which are limited sources and are major contributors to greenhouse gas emissions. Innovations in renewable energy technology, including increased efficiency of solar panels, more effective wind turbines, and more advanced biomass conversion methods, continue to lower the costs of producing this energy and make it more accessible for widespread use. In addition, the development of energy storage, such as more efficient lithium-ion batteries, allows the use of generated renewable energy more effectively, addressing one of the main challenges in its application, namely supply variability.

Water resources management is another area where innovation can play an important role in improving food and energy security. Smart irrigation techniques, which utilize soil moisture sensors and automation systems, can significantly reduce water use in agriculture while ensuring crops receive sufficient moisture for optimal growth. This approach not only helps in overcoming water scarcity but also reduces energy consumption associated with water distribution and use.

The concepts of circular food systems and energy efficiency offer holistic solutions to reduce waste and increase efficiency in production and consumption. In a circular food system, organic waste from agricultural processes and food consumption is reprocessed into resources, such as compost for agriculture or biogas as an energy source. This approach not only reduces the need for waste disposal but also provides valuable inputs for food and energy production. Energy efficiency, both in production and consumption, is also important. This can include everything from improving the efficiency of buildings and equipment to optimizing industrial processes to reduce energy consumption.

Overall, innovative solutions in food and energy security require the integration of advanced technologies, sustainability principles, and supportive policies to create systems that are resilient to current and future challenges. Through collaboration between researchers, industry, and policymakers, we can build a more sustainable future where food and energy security is achievable for all.

4. Policy Interventions for Sustainable Development

Facing food and energy security challenges requires more than just technological innovation; Strategic and sustainable policy interventions are also very necessary. Agricultural and energy policy reform is a crucial step in supporting the transition to more sustainable practices. Policies supporting sustainable agriculture could include incentives for the adoption of regenerative agricultural practices that improve soil health, increase biodiversity, and reduce emissions. On the energy side, policy reforms could target reducing subsidies for fossil fuels and increasing support for renewable energy through fiscal incentives or regulations that facilitate the development of clean energy infrastructure. Such policies will not only encourage the adoption of environmentally friendly technologies but also trigger innovation and investment in these sectors.

Investment and funding are other important pillars. To accelerate the adoption of sustainable agricultural technologies and clean energy, significant investment is needed from both the public and private sectors. Funding strategies can include tax incentives for investment in green technologies, research and development funds for sustainable innovation, as well as innovative financing mechanisms such as green bonds and climate funds that offer capital on favorable terms for sustainable projects. Building this supportive financial framework will accelerate the adoption of sustainable solutions and help overcome the funding constraints that sustainable initiatives often face.

International cooperation and partnerships also play an important role in overcoming this global problem. The food and energy security crisis knows no national borders, so it requires collaborative solutions. Initiatives such as the global partnership for food and energy security, involving governments, the private sector, non-profit organizations, and academic institutions, can improve coordination and knowledge sharing, as well as mobilize necessary resources. Collaboration like this

can facilitate technology transfer, strengthen global supply chains, and ensure that developing countries can also access sustainable solutions.

Finally, education and public awareness are important elements that are often overlooked in discussions about sustainable development. Raising awareness about the importance of food and energy security, as well as the impact of everyday activities on the environment, can fuel consumer demand for more sustainable products and services. Education about sustainable practices can start at the school level and continue through public information campaigns aimed at all age groups. Strengthening the role of communities in sustainable development also means encouraging active participation in local initiatives and public policies, from the use of renewable energy to waste reduction and responsible consumption.

Through a combination of policy reform, strategic investment, international cooperation, and education, we can build a strong foundation for sustainable development. Smart and targeted policy interventions will ensure that technological progress and innovation go hand in hand with social and economic change, leading to a greener, fairer, and more sustainable future for all.

E. CONCLUSION

The results of this research found that in overcoming the global food security crisis and energy shortages, a holistic and integrated approach is needed. The dynamics of the food and energy security crisis, exacerbated by population growth, climate change, system inefficiencies, and land use, require continued innovation and deep policy reform. Sustainable agricultural technologies, renewable energy development, efficient water resource management, and circular approaches in food and energy systems offer promising paths forward. However, their implementation depends on significant investment, international cooperation, bold policy reforms, and increased public awareness. To achieve sustainable development and overcome the food and energy security crisis, a strong global commitment to policy reform, increased investment in clean technologies, and strengthened cross-sectoral and international cooperation is needed. Public education and awareness also hold the key to changing behavior and supporting the adoption of sustainable solutions. Through collective efforts, innovation, and targeted policies, we can build a more sustainable future, ensure access to safe food and energy, and protect the planet for generations to come.

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