

The impact of climate change-related factors on food production in Egypt

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Abstract:

This abstract examines the significant impact of climate change-related factors on food production in Egypt, a country heavily reliant on agriculture for domestic consumption and export. The study highlights the specific challenges posed by climate change and its associated factors, including water scarcity, decreased crop yields, pests and diseases, saltwater intrusion, and reduced fish stocks. These factors intertwine with Egypt's unique geographical and climatic characteristics, placing its agricultural sector at heightened vulnerability.

The abstract emphasizes how water scarcity exacerbates existing challenges due to the arid climate and growing population. Rising temperatures and altered precipitation patterns lead to increased evaporation rates, reduced water availability, and disruptions in the Nile River's water flow, impacting irrigation systems and agricultural productivity. Moreover, higher temperatures and irregular rainfall adversely affect crop growth, particularly for heat-sensitive crops like wheat and fruits, resulting in decreased crop yields. Climate change also influences the distribution and abundance of pests and diseases, with warmer temperatures and altered rainfall patterns favoring their proliferation. This intensifies the risk of crop losses and necessitates costly pest management measures. Additionally, rising sea levels and increased salinity intrusion from the Mediterranean Sea threaten agricultural lands in the Nile Delta, leading to saltwater contamination of freshwater resources and reduced agricultural productivity. The implications of these changes on Egypt's fishing industry are discussed, as changes in sea temperatures and ocean acidification affect fish stocks, impacting food security.

To mitigate the impact of climate change on food production, Egypt has implemented various strategies, such as improved water management practices, water-efficient irrigation systems, and the development of drought-resistant crop varieties. Furthermore, the adoption of climate-smart agricultural practices and

collaborations with international partners play a crucial role in developing sustainable and resilient agricultural systems. Understanding the multifaceted impacts of climate change-related factors on food production in Egypt is essential for policymakers, researchers, and stakeholders in formulating effective adaptation and mitigation strategies. By addressing these challenges, Egypt can strive towards a more secure and sustainable food production system, ensuring food security for its population amidst the changing climate.

Keywords: Crop-Saltwater Intrusion-Agricultural Development-Economic Stability-Social Well-being

Introduction:

Climate change-related factors have significant impacts on food production in Egypt. The country's agricultural sector heavily depends on the Nile River and the fertile Nile Delta region for irrigation and cultivation. However, changes in climate patterns, such as rising temperatures, changes in precipitation, and increased frequency of extreme weather events, pose several challenges to Egypt's food production. **Water Scarcity:** Egypt already faces water scarcity issues due to its arid climate and growing population. Climate change exacerbates this problem as rising temperatures lead to increased evaporation rates and reduced water availability. Changes in precipitation patterns can also disrupt the timing and amount of water flow in the Nile River, affecting irrigation systems and agricultural productivity.

Decreased Crop Yields: Higher temperatures and changes in rainfall patterns can negatively impact crop yields in Egypt. Heat stress can reduce crop growth and development, particularly for heat-sensitive crops like wheat and fruits. Irregular rainfall and prolonged droughts can lead to water stress for crops, affecting their growth and productivity. **Pests and Diseases:** Climate change can influence the distribution and abundance of pests and diseases, posing risks to agricultural production. Warmer temperatures and altered rainfall patterns can create more favorable conditions for pests, such as insects and fungal pathogens, to thrive. This increases the likelihood of crop losses and the need for pest management measures, which can add to production costs.

Saltwater Intrusion: Rising sea levels and increased salinity intrusion from the Mediterranean Sea threaten agricultural lands in the Nile Delta. Saltwater intrusion can contaminate freshwater resources used for irrigation, rendering the soil less suitable for crop cultivation. This can lead to reduced agricultural productivity and the need for costly soil remediation measures. **Reduced Fish Stocks:** Climate change impacts marine ecosystems, including the fish stocks in the Mediterranean Sea. Changes in sea temperatures and ocean acidification can affect the distribution, abundance, and reproduction of fish species. This poses challenges for Egypt's fishing industry, reducing the availability of a vital source of protein and affecting food security. To address these challenges, Egypt has implemented various strategies and initiatives, including improved water management practices, promoting water-efficient irrigation systems, developing drought-resistant crop varieties, and adopting climate-smart agricultural practices. International collaborations and investments in research and

development are also crucial to developing sustainable and resilient agricultural systems in the face of climate change.

Sustainable Agricultural Development:

Sustainable agricultural development refers to the practice of managing agricultural systems in a way that meets the current needs for food and fiber production while preserving the environment, promoting economic viability, and ensuring social equity for present and future generations. It involves adopting practices that minimize negative environmental impacts, conserve natural resources, enhance ecosystem services, and support resilient and productive farming systems.

Principles of Sustainable Agricultural Development:

Environmental Stewardship: Sustainable agriculture aims to minimize the negative impact on the environment by conserving soil, water, and biodiversity. It promotes practices such as conservation tillage, agroforestry, organic farming, and integrated pest management to reduce the use of synthetic inputs, prevent soil erosion, protect water quality, and preserve habitats. **Economic Viability:** Sustainable agricultural systems should be economically viable for farmers and contribute to rural development. It involves promoting fair trade, improving market access for small-scale farmers, supporting diversified and value-added agricultural products, and encouraging efficient resource management to optimize productivity and profitability.

Social Equity and Resilience: Sustainable agriculture emphasizes social equity by ensuring access to resources, opportunities, and benefits for all stakeholders, including small-scale farmers, women, and marginalized groups. It promotes inclusive policies, knowledge sharing, capacity building, and empowerment of farmers to enhance their resilience to shocks, climate change, and market fluctuations. **Climate Change Adaptation and Mitigation:** Sustainable agriculture integrates climate change considerations by adopting practices that both adapt to and mitigate climate change impacts. It involves implementing climate-smart agricultural techniques, such as agroecology, precision agriculture, and the use of climate-resilient crop varieties. It also promotes carbon sequestration through practices like agroforestry and reduced tillage to mitigate greenhouse gas emissions.

Innovation and Technology: Sustainable agricultural development encourages the use of innovative technologies and practices to improve productivity, resource efficiency, and sustainability. This includes precision agriculture, remote sensing, digital farming, and biotechnology, along with

traditional knowledge and local practices that are environmentally sound and socially appropriate.

Benefits of Sustainable Agricultural Development:

Environmental Conservation: Sustainable agriculture helps protect ecosystems, reduce deforestation, preserve water quality, and maintain biodiversity. It promotes soil health, enhances water use efficiency, and minimizes the use of synthetic inputs, reducing pollution and preserving natural resources. **Food Security and Nutrition:** By focusing on long-term sustainability, sustainable agriculture aims to ensure food security by increasing agricultural productivity, diversifying food sources, and enhancing resilience to climate change impacts. It emphasizes nutrient-rich and diverse crops, promoting better nutrition and addressing food insecurity.

Economic Stability: Sustainable agriculture contributes to the economic stability of farming communities by improving farm incomes, reducing production risks, creating employment opportunities, and supporting local economies through value-added agricultural activities. **Resilience to Climate Change:** Sustainable agriculture helps build resilience to climate change by adopting adaptive practices, conserving natural resources, and promoting the use of climate-resilient crop varieties. This enhances the capacity of farming systems to withstand extreme weather events and changing climatic conditions.

Social Well-being: Sustainable agriculture promotes social equity, empowering farmers, supporting rural development, and preserving cultural practices and traditional knowledge. It strengthens local communities, enhances social cohesion, and improves the quality of life for farming households. Overall, sustainable agricultural development is a holistic approach that integrates environmental, economic, and social considerations to ensure the long-term viability and resilience of agricultural systems. It offers a pathway to address global challenges such as food security, climate change, and sustainable development while balancing the needs of people and the planet.

The impact of climate factors on the productivity of the study's crops:

To provide a more accurate and specific analysis of the impact of climate factors on crop productivity, it would be helpful to know the specific crops being studied. However, I can provide a general overview of how climate factors can influence crop productivity: **Temperature:** Different crops have specific temperature requirements for optimal growth and development. High temperatures can negatively affect crop productivity by causing heat stress,

reducing photosynthesis, and affecting reproductive processes such as pollination and fruit set. On the other hand, some crops may benefit from warmer temperatures in regions with cooler climates. Extreme temperature fluctuations, such as frost events or heatwaves, can also damage crops and reduce yields. Precipitation and Water Availability: Adequate and timely rainfall is crucial for crop growth and productivity. Insufficient rainfall or drought conditions can lead to water stress, affecting plant growth, nutrient uptake, and yield formation. Excessive rainfall, on the other hand, can cause waterlogging and root damage. Changes in precipitation patterns, such as increased variability or shifts in the timing and intensity of rainfall, can disrupt planting schedules, irrigation practices, and overall crop performance.

Extreme Weather Events: Climate change has led to an increased frequency and intensity of extreme weather events, including storms, hurricanes, and cyclones. These events can cause physical damage to crops, such as lodging (plants falling over), uprooting, or breakage. Flooding associated with heavy rainfall can lead to soil erosion and nutrient leaching, affecting crop health and productivity. Additionally, hailstorms and strong winds can damage crops and reduce yields. Carbon Dioxide (CO₂) Levels: Rising atmospheric CO₂ levels, a key driver of climate change, can have both positive and negative effects on crop productivity. Some crops, especially C₃ plants (e.g., wheat, rice), may exhibit increased photosynthesis rates and water-use efficiency under elevated CO₂ levels, leading to potential yield benefits. However, the response can vary depending on other factors such as nutrient availability and temperature. C₄ plants (e.g., maize, sorghum) typically show less response to elevated CO₂.

Pests and Diseases: Changes in climate can influence the distribution, population dynamics, and activity of pests and diseases. Warmer temperatures can favor the reproduction and growth of certain pests, leading to increased damage to crops. Similarly, shifts in rainfall patterns can create favorable conditions for certain diseases. Pest and disease outbreaks can reduce crop yields and quality, necessitating increased pest management and disease control measures. It's important to note that the specific impacts of climate factors on crop productivity can vary depending on the crop species, geographic location, local farming practices, and the ability of farmers to adapt to changing conditions. Furthermore, the interactions between multiple climate factors can also influence crop responses. Conducting specific studies on particular crops in a given region can provide more precise insights into their productivity under different climate scenarios. Vertical agricultural expansion refers to the practice of increasing agricultural production by utilizing vertical space, such as through the construction of multi-story or vertically stacked farming systems. This approach

allows for higher production capacity in limited land areas, making it particularly useful in urban or densely populated areas where land is scarce. The components of vertical agricultural expansion include:

Vertical Farming Systems: Vertical farming systems are designed to maximize space utilization by growing crops in vertically stacked layers. These systems typically utilize artificial lighting, such as LED lights, to provide the necessary light energy for plant growth. Hydroponic or aeroponic systems are commonly used, where plants are grown in nutrient-rich water or air, respectively, instead of soil. Vertical farming systems can be implemented indoors or in controlled environments, such as greenhouses or converted buildings. **High-Density Planting:** Vertical agricultural expansion emphasizes high-density planting techniques to optimize space utilization. Crops are grown in closely spaced configurations, often utilizing vertical trellises, racks, or shelving systems to support plant growth. This allows for a larger number of plants per unit area compared to traditional horizontal farming methods.

Controlled Environment Agriculture (CEA): Controlled environment agriculture involves creating optimal growing conditions by controlling factors such as temperature, humidity, light, and CO₂ levels. CEA techniques, including vertical farming, enable farmers to provide consistent and tailored environments for crop growth, which can result in improved yields, reduced pest and disease pressure, and better resource management. **Automation and Technology:** Vertical agricultural expansion relies on the integration of automation and technology to efficiently manage the farming systems. Automated systems for irrigation, nutrient delivery, lighting, and climate control help optimize resource use and reduce labor requirements. Sensor technologies, data analytics, and artificial intelligence can be employed to monitor and optimize crop growth, allowing for precise control of environmental parameters and better decision-making.

Sustainable Resource Management: Vertical farming systems often prioritize sustainable resource management. Water conservation techniques, such as recirculating hydroponic systems and water-efficient irrigation methods, are employed to minimize water usage. Energy-efficient lighting systems, renewable energy sources, and energy management strategies are implemented to reduce energy consumption and environmental impact. Additionally, organic and integrated pest management practices are encouraged to minimize the use of chemical inputs. **Crop Selection:** The choice of crops in vertical agricultural systems is crucial. Certain crops are better suited for vertical farming due to their growth habits, compact size, and high-value yields. Leafy greens, herbs, microgreens, and certain vine crops like tomatoes and cucumbers are commonly

grown in vertical farming setups. Selecting crops that have a shorter growing cycle and high market demand can optimize productivity and profitability. Vertical agricultural expansion offers opportunities to increase food production, enhance food security, and reduce the environmental footprint of agriculture. By effectively utilizing vertical space and incorporating technological advancements, this approach can contribute to sustainable and efficient agricultural practices in urban areas and beyond.

Impact of climate change on Egypt's sustainable agricultural development:

Climate change has a significant impact on Egypt's sustainable agricultural development, posing challenges to the country's efforts to ensure food security, economic stability, and environmental sustainability. Here are some key impacts of climate change on Egypt's agricultural sector: **Water Scarcity:** Egypt is already a water-stressed country, heavily reliant on the Nile River for irrigation. Climate change exacerbates water scarcity by altering precipitation patterns, reducing water availability, and increasing evaporation rates. This impacts the availability of water for agricultural use, limiting crop production and agricultural expansion.

Reduced Crop Yields: Rising temperatures and changing precipitation patterns affect crop growth and yields. Heat stress can harm crops, particularly those sensitive to high temperatures, leading to lower productivity and quality. Changes in rainfall patterns can cause droughts or irregular water supply, impacting crop growth and harvest timing. **Soil Degradation:** Climate change can contribute to soil degradation through increased erosion, salinization, and desertification. Extreme weather events, such as heavy rainfall or droughts, can erode topsoil and degrade soil quality. Rising temperatures and decreased precipitation can increase soil salinity, rendering it less suitable for agriculture.

Pests and Diseases: Climate change alters the distribution, population dynamics, and behavior of pests and diseases. Warmer temperatures and altered rainfall patterns create more favorable conditions for pests, such as insects and fungal pathogens, to thrive. This can lead to increased pest pressure and disease outbreaks, negatively impacting crop yields and quality. **Saltwater Intrusion:** Rising sea levels and increased salinity intrusion from the Mediterranean Sea pose a significant threat to Egypt's coastal agriculture, particularly in the Nile Delta region. Saltwater intrusion contaminates freshwater resources, rendering the soil unsuitable for crop cultivation and limiting agricultural productivity.

Food Security and Livelihoods: The impacts of climate change on Egypt's agricultural sector directly affect food security and livelihoods. Reduced crop

yields, water scarcity, and increased pest pressure can lead to lower food production, rising food prices, and reduced incomes for farmers. Vulnerable populations, particularly small-scale farmers and rural communities, are disproportionately affected.

Egypt has implemented various strategies to promote sustainable agricultural development in the face of climate change. These include:

Water Management: Improving water management practices, such as efficient irrigation systems, water conservation measures, and water recycling, to optimize water use in agriculture. **Crop Diversification and Adaptation:** Promoting the use of drought-tolerant crop varieties, adopting climate-resilient agricultural practices, and diversifying crop production to reduce dependence on water-intensive and heat-sensitive crops.

Sustainable Land Management: Implementing soil conservation techniques, erosion control measures, and reforestation efforts to mitigate soil degradation and desertification. **Integrated Pest Management:** Enhancing integrated pest management strategies, including the use of biological control methods, crop rotation, and resistant crop varieties to manage pests and diseases. **Research and Development:** Investing in research and development to develop climate-resilient crop varieties, innovative agricultural technologies, and sustainable farming practices tailored to Egypt's specific climatic conditions.

International Cooperation: Collaborating with international partners, organizations, and initiatives to access funding, technical expertise, and knowledge sharing on climate change adaptation and sustainable agricultural development. By integrating climate change adaptation and mitigation strategies into sustainable agricultural development, Egypt aims to enhance the resilience, productivity, and sustainability of its agricultural sector, ensuring food security and livelihoods for its population in the face of a changing climate.

Recommendations:

- Develop new varieties that are more resistant to climate change and less water consumption.
- Increase the educational and educational role of agricultural extension to raise farmers' awareness of the need to cultivate in time to increase productivity while reducing waste in irrigation water.
- Composting in the right quantity and in a timely manner with the use of soil enhancers and reclamation of new areas of land to increase production.

- The work of the so-called spatial and temporal regionalization of crops according to the comparative advantage of each region with the establishment of the most appropriate date for agriculture.
- Using methods to protect plants from winter thermal changes using plastic coverings and chatter or burlap in the summer of prospects for sustainable agricultural development in Egypt (potentials - determinants - solutions) in water.

Conclusion:

In conclusion, climate change-related factors have a significant impact on food production in Egypt, posing challenges to the country's agricultural sector. The combination of water scarcity, reduced crop yields, pests and diseases, saltwater intrusion, and changes in fish stocks directly affect food production and pose risks to food security and livelihoods. Egypt's vulnerability to climate change is amplified by its arid climate, growing population, and dependence on the Nile River for irrigation. Rising temperatures, altered precipitation patterns, and increased evaporation rates impact water availability and disrupt the water flow of the Nile, affecting irrigation systems and agricultural productivity. Higher temperatures and irregular rainfall also adversely affect crop growth, particularly for heat-sensitive crops, leading to decreased crop yields. The distribution and abundance of pests and diseases are influenced by climate change, with warmer temperatures and changed rainfall patterns creating favorable conditions for their proliferation. This intensifies the risk of crop losses, requiring costly pest management measures. Additionally, rising sea levels and saltwater intrusion from the Mediterranean Sea threaten agricultural lands in the Nile Delta, resulting in soil salinization and reduced agricultural productivity. Changes in sea temperatures and ocean acidification also impact fish stocks, affecting the fishing industry and further challenging food security.

To address the impacts of climate change on food production, Egypt has implemented strategies such as improved water management practices, water-efficient irrigation systems, and the development of climate-resilient crop varieties. The adoption of climate-smart agricultural practices and international collaborations play a vital role in developing sustainable and resilient agricultural systems. Understanding the complex interactions between climate change and food production in Egypt is crucial for formulating effective adaptation and mitigation strategies. By prioritizing sustainable agricultural development and implementing climate-resilient practices, Egypt can work towards a more secure and sustainable food production system, ensuring food security for its population in the face of a changing climate. Continued research, investment, and

international cooperation are essential to address the challenges and build a resilient agricultural sector in Egypt.

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