Exploring Economic Opportunities and Challenges in Sustainable Agriculture: A Qualitative Analysis of Egypt's New Delta Project

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Abstract

This study presents a comprehensive economic analysis of sustainable agriculture within Egypt's New Delta Project, a large-scale national initiative aimed at agricultural expansion and resilience in arid environments. Employing a qualitative research design, twelve in-depth, semi-structured interviews were conducted with economic experts directly involved in the project's planning and implementation. The data were analyzed using thematic analysis facilitated by NVivo software, resulting in the identification of four core themes. The first theme, Economic Sustainability, encompasses diversification, economic viability, resilience, and feasibility as essential pillars of long-term agricultural development. The second theme, Non-financial Determinants of Sustainability, highlights the influence of social, institutional, and environmental factors—such as food security, rural employment, and ecological restoration—on sustainable agricultural outcomes. The third theme, Financial Drivers of Sustainable Agriculture, underscores the importance of financial incentives, access to credit, cost efficiency, and public-private partnerships. The fourth theme, Challenges to Sustainability, identifies key environmental and structural constraints, including climate change, water scarcity, and soil degradation, which necessitate integrated and adaptive policy responses.

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The study concludes with policy recommendations to enhance economic resilience, promote climate-smart agriculture, and optimize financial frameworks. This research contributes to the academic discourse on sustainable agriculture in arid regions and offers empirical insights for enhancing the effectiveness of mega-agricultural projects in Egypt and similar contexts.

Keywords: Sustainable agriculture, economic analysis, New Delta Project, Egypt, qualitative research, thematic analysis, policy recommendation

تحليل نوعي للفرص والتحديات الاقتصادية في الزراعة المستدامة: دراسة حالة مشروع الدلتا الجديدة في مصر

الملخص

تهدف هذه الدراسة إلى تقديم تحليل اقتصادي عميق لمفهوم الزراعة المستدامة في إطار مشروع الدلتا الجديدة بمصر، وهو مشروع وطني واسع النطاق يستهدف التوسع الزراعي وتعزيز القدرة على الصمود في البيئات الجافة. اعتمدت الدراسة منهجاً نوعياً، حيث تم إجراء اثنتي عشرة مقابلة شبه مهيكلة مع خبراء اقتصاديين مشاركين بصورة مباشرة في تخطيط المشروع وتنفيذه. وقد تم تحليل البيانات باستخدام منهج التحليل الموضوعي بمساعدة برنامج NVivo ، مما أسفر عن استخلاص أربعة محاور رئيسة. يتمثل المحور الأول في "الاستدامة الاقتصادية"، ويتضمن مفاهيم التنويع، والجدوى الاقتصادية، والمرونة، وقابلية التنفيذ، كمرتكزات أساسية لتحقيق تنمية زراعية طويلة الأمد. أما المحور الثاني، "المحددات غير المالية للاستدامة"، فيُبرز الأثر الجوهري للعوامل الاجتماعية والمؤسسية والبيئية مثل الأمن الغذائي، وتوفير فرص العمل في المناطق الريفية، واستعادة التوازن البيئي في تحقيق أهداف الزراعة المستدامة. ويُسلط المحور الثالث، "الدوافع المالية للزراعة المستدامة"، الضوء على أهمية الحوافز الاقتصادية، وإتاحة التمويل، وكفاءة التكاليف، والشراكات بين القطاعين العام والخاص في دعم الاستدامة الزراعية. في حين يناقش المحور الرابع، "التحديات التي تواجه الاستدامة"، أبرز المعوقات البيئية والهيكلية، مثل التغير المناخي، وندرة الموارد المائية، وتدهور التربة، والتي تتطلب تبنّي سياسات تكاملية وتكيفية.

تختتم الدراسة بجملة من التوصيات والسياسات الرامية إلى تعزيز القدرة الاقتصادية على التكيف، وتطبيق ممارسات الزراعة الذكية مناخياً، وتطوير الأطر التمويلية الملائمة ،كما تسهم هذه الدراسة في إثراء الأدبيات الأكاديمية حول الزراعة المستدامة في المناطق القاحلة، وتوفر معطيات تطبيقية يمكن الاستفادة منها في تحسين فعالية المشاريع الزراعية الكبرى في مصر وسياقات مماثلة.

الكلمات المفتاحية :الزراعة المستدامة، التحليل الاقتصادي، مشروع الدلتا الجديدة، مصر، البحث النوعي، التحليل الموضوعي، السياسات العامة.

INTRODUCTION

Sustainable agriculture is essential for achieving food security and long-term development, particularly in arid and semi-arid regions (Metwaly et al., 2024). It relies on understanding soil characteristics and leveraging remote sensing and machine learning to optimize resource use and improve productivity at scale (Metwaly et al., 2024). At the same time, agriculture remains a key driver of economic growth, offering employment and income for rural populations and serving as a primary source of food (Talwani et al., 2024).

Egypt's agricultural sector faces mounting challenges, including a population exceeding 114 million in 2024, reliance on food imports, limited water resources, and the impacts of climate change. In this context, agrifood-tech innovations have become vital. Over the past decade, Egypt has developed a dynamic agri-innovation ecosystem comprising public institutions, startups, research centers, and private investors—now positioning the country as a leading African hub for agrifood technology (Vitón et al., 2024).

However, the success of national initiatives such as the New Delta Project depends not only on technological advancements but also on a thorough understanding of their economic feasibility, long-term benefits, and social impact. Sustainable agriculture must encompass economic returns, investment efficiency, and improved livelihoods.

This study aims to investigate the economic dimensions of sustainable agriculture within Egypt's New Delta Project. Using a qualitative research approach, the study explores key economic enablers and constraints through expert interviews.

The objective is to provide a nuanced understanding of how economic factors—both financial and non-financial—shape the sustainability and long-term success of large-scale agricultural initiatives in arid environments.

LITERATURE REVIEW

1. Sustainable Agriculture in Egypt's New Delta Project

Agriculture is one of the basic columns of the Egyptian economy, as it directly contributes to achieving food security, providing job opportunities and promoting rural development, and with the increasing challenges facing the agricultural sector, headed by water scarcity, climate change, and accelerated population expansion, sustainable agriculture highlights as an indispensable strategic option to achieve a balance between development requirements and protecting natural resources for the coming generations (Abdelzaher and Awad, 2022).

Agriculture is a cornerstone of the Egyptian economy, contributing approximately 11 percent to Egyptian GDP and engaging around 20 percent of the labor force. The trajectory of the country's agricultural policies since the 1950s reflects the influence of diverse economic, political, and social factors. Over time, the primary focus has been to ensure affordable food for the local population and provide sustainable income and employment within the sector. Recently, Egypt has updated its 2030 Sustainable Agricultural Development Strategy (SADS), aligning with the country's Vision 2030 plan. This strategy emphasizes resource efficiency, the application of modern technologies, and the promotion of agri-industrialization. Key pillars include efforts to reclaim desert land, enhance green initiatives, and bolster water availability for irrigation in Africa (Vitón et al., 2024).

In this context, the New Delta project represents one of the largest development initiatives launched by the Egyptian state to enhance the optimal exploitation of the desert lands in the west of the Nile River. The project aims to add more than two million acres to the agricultural area through the application of smart and sustainable agricultural practices that guarantee the efficient use of water and energy while relying on modern irrigation systems such as drip irrigation and smart irrigation in addition to the use of water sources Unconventional, such as sea water, and exhaust water treatment (Mohamed and Gouda, 2018).

This project is important because it is a practical model for integrating agricultural development and the environmental dimension in reducing pressure on the old agricultural lands in the delta and valley. It supports adaptation to climate change and enhances food and national security in light of its limited water resources and high import rates from abroad (Abdelzaher and Awad, 2022).

Accordingly, the study of economic dimensions of sustainable agriculture in the new Delta project acquires great importance, especially in light of the government trends towards rationalizing the use of water, adopting modern agricultural techniques, and providing the appropriate infrastructure for the growth of this vital sector in a sustainable manner.

2. Opportunities in Sustainable Agriculture

a) Increased Agricultural Productivity

Increasing the agricultural production indicates the efforts made to improve the efficiency of the use of lands and water in the desert environments designed through the transition to more sustainable crops such as trees instead of seasonal crops and the use of modern opinion systems instead of the surface and low

efficiency in addition to relying on remote sensing techniques for monitoring agricultural changes as it aims to enhance food security and provide opportunities He worked and restored the population increase in new areas away from the Nile Valley and the traditional Delta (Abdelzaher and Awad, 2022).

Therefore, production includes an increase in agricultural production. Evaluating the Earth's effectiveness in producing crops based on factors such as fertility, security, protection, social acceptance, and economic feasibility. This increase in productivity includes improving modern methods and practices for the management of the land and water that fit with local conditions, which helps to sustain agricultural production in the future (Mohamed and Gouda, 2018).

b) Achieving Environmental Sustainability

Achieving environmental Sustainability indicates the inclusion of environmental considerations in decision-making processes in early stages of planning and policies to ensure that policies, programs, and plans are compatible with sustainable development goals by achieving a balance between environmental, social, and economic dimensions (Hegazy and Tohlob, 2024).

The achievement of environmental Sustainability includes treating the unique environmental challenges facing the country, such as the scarcity of water, desertification and pollution, as well as the potential effects of climate change, such as the high level of the sea, which affects the Nile Delta, where it can be identified and treated as possible environmental effects for development projects in a proactive manner, which helps to ensure the achievement of the goals of its advantage Hegazy and Tohlob, 2024).

c) Enhancing Climate Change Adaptation

Enhancing adaptation to climate change refers to a set of comprehensive strategies that focus on adjusting agricultural systems to confront the increasing environmental challenges, this includes the development of varieties of crops that make up heat and salinity and improve irrigation technologies and diversify crops as well as the application of water conservation techniques and soil in addition to this requires promoting awareness and continuous training for farmers through agricultural education programs and agricultural extension, which is It helps them to adopt appropriate adaptation strategies and The government plays this role by providing financial and technical support in addition to improving the localization and enhancing coordination between all concerned parties, such as researchers and international organizations, to ensure the adoption of these strategies effectively through these procedures (Kassem et al., 2019).

d) Development of Agricultural Technologies

The development of agricultural technologies focuses on integrating innovative technologies to improve agricultural practices and ensuring their responsibility. Technologies can include artificial intelligence (AI), machine learning (ML), the Internet of things (IOT), or big data, and blockchain technology, as these technologies help improve agricultural production, resource allocation, and decisions, as artificial intelligence can help, learn deity in monitoring crops, identifying pests and diseases, and expecting returns while the Internet can be tasks such as crops and monitor By analyzing large groups of data from various sources, such as satellite images and soil sensors, in addition to that, including the transparent block technology and the possibility of tracking products in the agricultural supply series while cyber security protects agricultural data

from digital threats, these technological developments are necessary to adapt to climate change and enhance food security by improving and efficiently using practices Agricultural (Talwani et al., 2024).

e) Knowledge Exchange and Support

Knowledge exchange and support refers to the process of benefiting from international knowledge and technologies to address local gaps, as it emphasizes the importance of international ties to facilitate access to new technologies and encourage the exchange of knowledge and adapting innovations to meet the needs of local markets (Vitón et al., 2024). Therefore, it means communicating with the global environmental systems of food and agriculture techniques to benefit from its experiences and apply the appropriate innovations for the unique agricultural challenges that they face and the aim of them is not only to import or copy innovations but also to adapt them strategically to meet local needs and expand them to include the region and this approach can push to exchange capabilities by linking international partners and enhancing local environmental systems Improving access to technologies and basic knowledge, and strategic cooperation is like the last agreement between Egypt and China on the adoption of drought -resistant crops, an example of this effort to enhance technology transport and promote agricultural innovation Africa (Vitón et al., 2024).

3. Challenges in Sustainable Agriculture

a) Limited Access to Information and Technologies

With the increasing challenges facing the agricultural sector, and with Egypt's population exceeding 100 million, and the need to reduce dependence on food imports, the importance of harnessing technological innovation to improve agricultural

production and achieve sustainability has emerged (Awaludin et al., 2024). Recent years have witnessed the emergence of an ecosystem, food and climate driven by digital transformation, including government agencies, research institutions, business incubators, investors, and entrepreneurs. The use of precision agriculture tools, smart control of irrigation systems, and post-harvest applications are among the most prominent methods that support the quality and safety of export products. The adoption of digital technologies represents a decisive step towards building a competitive Egyptian agricultural sector capable of innovation and achieving global quality standards in its export products, while enhancing food security and transitioning towards a greener and more sustainable economy (Awaludin et al., 2024).

b) Government Incentive Constraints

Government Incentive Constraints refers to the constraints or distortions that occur when government subsidies are not allocated solely based on innovation capacity or financial need, but are also influenced by political connections, corruption, or the efficiency of the public bureaucracy. These constraints affect the effectiveness of support programs, which may lead to unfair competition, inefficient resource allocation, or poor efficiency. Although subsidies are intended to support financially constrained firms, especially small or medium-sized enterprises, there are persistent concerns that political connections may influence the distribution of these subsidies, limiting the intended positive asset and creating systemic inefficiencies (Li et al., 2021).

c) Complexity of Integrated Farm Management (IFM)

The complexity of integrated farm management lies in its being a flexible framework that combines modern technologies and

traditional methods to achieve a balance between economic schedule, environmental sustainability, and social responsibility, with different interpretations and challenges in application and understanding among the stakeholders (Mohanty and Nayak 2020).

d) Barriers To Knowledge Exchange

The barriers To Knowledge Exchange are the factors that hinder the participation and the application of knowledge between the various parties concerned (Metwaly et al., 2024). These barriers vary between several major aspects, as they can include challenges in communication such as difficulty understanding information due to the different terms or complicating, which makes the exchange of knowledge ineffective as the lack of confidence between farmers, advisors and researchers is a great barrier where it is difficult to communicate good and exchange identification in the absence of confidence exchange. In addition, there are cultural and social barriers represented in the traditions and social patterns that may hinder the acceptance of the new knowledge if they contradict the traditional methods, so that material restrictions such as the lack of financial resources, time or technology can impede access to knowledge and their application, and that the lack of identification of knowledge with the local reality can lead to its consideration of its uselessness as it was not applied in Local context (Metwaly et al., 2024).

e) Farmer Resistance to Change

Farmers resistance refers to change to the frequency or rejection that some farmers express to the adoption of new agricultural practices and technologies, the most prominent of this resistance in several forms, including the great dependence on traditional agricultural systems and seasonal or immigrant workers, which led to clear imbalances in production, as well as

the weak adoption of water conservation techniques despite the limited water resources in areas such as areas For numbness and the absence of flexibility in dealing with the challenges associated with chains, supply and distribution, which led to the tip of the crops or the lack of food supply, and this is attributed to several factors, including the lack of awareness of modern technology and its limited financial resources and fear of failure or loss resulting from changing methods so I am resisting in change that represents one of the fundamental challenges that face the presence of the development of sustainable agriculture, especially among young people Farmers (Selim et al., 2022).

f) Cost-Benefit Analysis

Cost-Benefit Analysis is an economic evaluation tool that aims to compare the total costs associated with the project with the benefits of economic, social, and environmental, considered. This analysis includes calculating the investment costs of equipment, infrastructure, employment costs, secondary maintenance, consumption, labor costs, and energy, as well as the costs associated with changing the properties of soil and irrigation (Wahid et al., 2024).

The challenges facing sustainable agriculture include the difficulty of integrating external environmental impacts into the analysis, the lack of accurate and comprehensive data for assessing the environmental and social impact of projects, and the challenges associated with adopting a social perspective rather than a private perspective in assessments. The role of innovation and technological development in improving production efficiency is also highlighted, but it is difficult to calculate the costs and benefits associated with long-term or uncertain technologies, which increases the complexity of assessment processes (Samat et al., 2024).

g) Measurable Economic Feasibility

Measurable Economic Feasibility refers to the process of evaluating and determining the financial viability and practicality of implementing carbon capture and storage (CCS) technology, especially for power plants. This includes analyzing several factors, such as cost-effectiveness, return on investment, potential economic benefits, and the overall financial impact of CCS projects compared to other strategies, such as renewable energy options. It includes the concept of evaluating the economic performance of CCS technologies in specific scenarios such as different fuel types, power plant configurations, and regional economic conditions through methods such as technology and economic performance assessments, electricity cost analysis, net present value, and sensitivity analysis to understand the financial viability of CCS technologies in different contexts and regions (Naseeb et al., 2022).

h) High Costs

The high cost of sustainable agriculture is evident in several aspects. Advanced technologies such as the Internet of Things, drones, and agricultural robots require large initial investments, which places a financial burden on farmers, especially in developing countries. Furthermore, the use of renewable energy to operate these technologies is expensive, especially in rural areas that lack affordable energy sources. In addition, the costs of developing and maintaining infrastructure such as communication networks and smart devices, contribute to increasing the overall costs.

RESEARCH METHODOLOGY

This study adopts a qualitative research design to provide a comprehensive economic perspective on sustainable agriculture

within Egypt's New Delta Project. Recognizing the complexity and context-specific nature of the challenges involved, qualitative methods are deemed most appropriate to capture the depth and nuance of expert insights, particularly regarding factors that are difficult to measure quantitatively. Data were collected through semi-structured interviews conducted with a purposive sample of stakeholders directly engaged with the New Delta Project. In total, twelve interviews were held with economic experts working in various capacities within the project, including academic researchers, field practitioners, and local decision-makers. Participants were selected based on their expertise and involvement in the project's implementation and management. The semi-structured format allowed for flexibility in probing key themes while ensuring consistency across interviews. The questions focused on identifying the main economic challenges facing sustainable agriculture in the project, as well as critical success factors within the project's operating environment.

The collected interview data were transcribed verbatim and analyzed using thematic analysis, a method well-suited for identifying, analyzing, and reporting patterns (themes) within qualitative data. NVivo software was utilized to assist in the coding process, enabling a systematic and transparent analysis. Thematic analysis was conducted following a structured approach:

1- Familiarization with the data through repeated reading of transcripts.

2- Initial coding of significant features of the data.

3- Searching for themes by grouping related codes.

4- Reviewing and refining themes to ensure coherence and relevance to the research objectives.

5- Defining and naming themes to provide clear insights into the factors affecting the project.

The use of NVivo facilitated the organization of data, coding consistency, and retrieval of thematic content, enhancing the rigor and reliability of the analysis. All participants were informed about the purpose of the study and provided their consent before participating. Anonymity and confidentiality were assured, and participants were given the option to withdraw at any stage without any consequences.

FINDING AND RESULTS

To gain a deeper understanding of the economic opportunities and challenges associated with sustainable agriculture in Egypt's New Delta Project, twelve in-depth interviews were conducted with economic experts directly engaged in or knowledgeable about the project. These interviews provided valuable insight into the practical and strategic dimensions of sustainable agriculture in this transformative national initiative. The purpose of analyzing these interviews is to uncover expert perspectives that can inform policy decisions and strategic planning in the context of the New Delta's agricultural development.

The data collected from these interviews were analyzed using thematic analysis, a widely used qualitative research method that allows for the systematic identification, organization, and interpretation of patterns of meaning (or "themes") within qualitative data. Thematic analysis is particularly well-suited to exploratory studies aiming to capture expert knowledge, experiences, and perceptions in a structured yet flexible manner.

The process of thematic analysis typically involves six key steps:

1. **Familiarization with the data** – reading and re-reading the interview transcripts to become deeply familiar with the content. This was accomplished by transcribing the audio recordings of the 12 interviews into Microsoft Word documents, which were then imported into NVivo 12 for thematic analysis.
2. **Generating initial codes** – identifying and labeling segments of text that appear relevant to the research question. The second step involved generating initial codes by assigning relevant labels to key data extracts from the 12 expert interviews. This process focused on identifying significant patterns related to economic opportunities and challenges in sustainable agriculture within Egypt's New Delta Project, while also exploring relationships between codes that could inform the development of overarching themes aligned with the study's aim.
3. **Searching for themes** – grouping related codes into broader patterns that reflect important aspects of the data. The third step in the analysis involved identifying preliminary themes by generating a word cloud from the 12 expert interviews. This word cloud visually highlighted the top 150 terms that appeared at least three times across the dataset, with larger words indicating higher frequency or relevance. This visual representation helped uncover recurring concepts related to economic opportunities and challenges in sustainable agriculture within Egypt's New Delta Project, guiding the development of key thematic areas aligned with the

study's objective. Figure 1 shows the word cloud that was generated from the analysis.

Figure 1: Word Cloud

4. **Reviewing themes** – refining and validating the themes by checking them against the data set to ensure coherence and relevance. This stage involved grouping related codes to form coherent themes while also distinguishing those that were unique. The researcher carefully analyzed the coded data, identifying underlying patterns and relationships among the codes to ensure that each theme accurately reflected the expert insights. Through this process, four key themes emerged from the interviews, capturing the core economic opportunities and challenges associated with sustainable agriculture in Egypt's New Delta Project. These themes are:

    a) Theme of Economic Sustainability

    b) Theme of Non-financial Factors Enhance the Sustainable Agricultural Practices

    c) Theme of Financial Factors Enhance the Sustainable Agricultural Practices

d) Theme of Challenges Face Sustainable Agricultural Practices

5. **Defining and naming themes** – clearly articulating what each theme represents and how it relates to the overall research question. The themes are clearly defined, and corresponding codes or sub-themes are identified. The findings from this stage are presented in Table 1.

Table 1: Themes and Codes Table

Major Themes	Sub-themes	Reference	Total
Theme of Economic Sustainability	1. Economic Diversification	20	77
	2. Economic Viability	21	
	3. Economic Resilience	15	
	4. Economic Feasibility	21	
Theme of Non-financial Factors Enhance the Sustainable Agricultural Practices	1. Food Security	18	111
	2. Rural Employment	10	
	3. Market Integration	17	
	4. Policy Framework	20	
	5. Ecological Restoration	20	
	6. Technological Innovations	26	
Theme of Financial Factors Enhance the Sustainable Agricultural Practices	1. Cost Efficiency	25	140
	2. Financial Incentives	24	
	3. Subsidies	21	
	4. Credit Access	16	
	5. Public-Private	17	

	Partnerships		
	6. Profitability	37	
Theme of Challenges Face Sustainable Agricultural Practices	1. Climate Change	15	39
	2. Water Scarcity	11	
	3. Soil Degradation	13	

6. **Producing the report** – integrating the themes and supporting data into a narrative that provides a meaningful interpretation of the findings. In the following section, each of these themes will be explored in detail, along with the specific codes that were identified within them. These findings offer a nuanced view of the expert perspectives on both the enablers and obstacles to sustainable agriculture in Egypt's New Delta Project.

1. Theme of Economic Sustainability

The Theme of Economic Sustainability reflects the experts' views on how Egypt's New Delta Project can create lasting economic value through sustainable agricultural development. This theme captures the economic opportunities identified in the interviews that contribute to a robust and adaptable agricultural sector capable of supporting long-term growth. It emphasizes the importance of designing agricultural practices and policies that not only generate income but also ensure stability, adaptability, and efficiency over time. This theme emerged from four interrelated codes:

Economic Diversification: Refers to expanding the range of agricultural products and activities to reduce dependence on a single crop or sector, thereby enhancing income stability and reducing economic risk. The interviews revealed several indications of this code, for example, three, seven and ten

interviews, respectively, indicated the following indications: "My work ensures these practices align with national goals of economic diversification, food security, and rural employment", "Benefits include improved food security, diversified income sources, and enhanced rural employment—contributing to national economic diversification" and "These include improved food security, stable rural employment, higher yields, and stronger economic diversification, all contributing to enhanced economic resilience".

Economic Viability: Focuses on the ability of agricultural ventures in the New Delta to be profitable and self-sustaining in the long term, considering factors like cost-efficiency, market demand, and productivity. The interviews revealed several indications of this code, for example, one, five and twelve interviews, respectively, indicated the following indications: "This rate plays a crucial role in assessing the economic viability of investments in sustainable agriculture", "Economic viability in this context involves analyzing the return on investment of sustainable methods under constraints like water scarcity and soil degradation" and "Economic viability, in this context, refers to the capacity of sustainable farming practices to generate sufficient financial returns, reduce input and maintenance costs over time, and remain resilient to external shocks such as market fluctuations or climate variability".

Economic Resilience: Represents the capacity of the agricultural system to absorb shocks—such as climate events, price fluctuations, or supply disruptions—and continue to function effectively. The interviews revealed several indications of this code, for example, two, eight and eleven interviews, respectively, indicated the following indications: "Lower chemical input needs, better soil fertility, and resilience to climate events reduce overall costs in the long run", "Advisory

services and continuous training are critical for technology adoption and effective resource use, directly contributing to economic resilience and food security" and "By integrating technological innovations, we aim to enhance economic resilience and promote economic diversification within the agricultural sector".

Economic Feasibility: Concerns the practical and financial practicality of proposed agricultural initiatives, including cost-benefit considerations, access to funding, and the scalability of projects within the New Delta context. The interviews revealed several indications of this code, for example, five, seven and nine interviews, respectively, indicated the following indications: "With technological innovations, we aim to optimize these expenditures to improve overall economic feasibility", "The economic feasibility often hinges on long-term returns, which can be uncertain due to climatic and market fluctuations" and "Economic feasibility refers to the ability to implement agricultural practices that are both environmentally sound and financially self-sustaining". Figure 2 Shows the mind map that emerged from NVivo analysis for theme of economic sustainability and its codes.

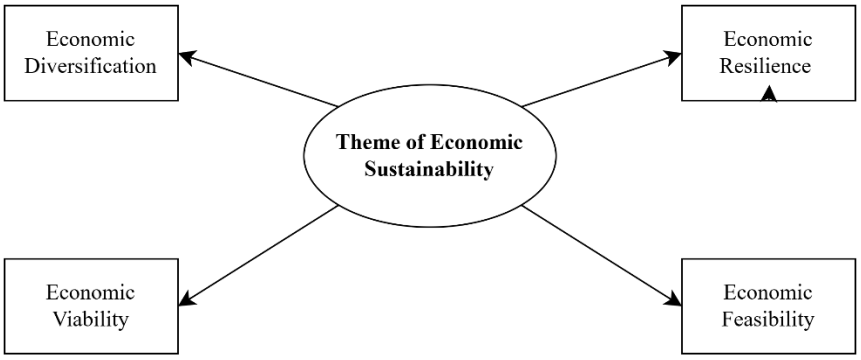

Figure 2: Theme of Economic Sustainability and Its Codes

2. Theme of Non-financial Factors Enhance the Sustainable Agricultural Practices

The Theme of Non-financial Factors Enhance the Sustainable Agricultural Practices highlights the critical role of social, environmental, institutional, and technological elements in promoting sustainable agriculture within Egypt's New Delta Project. From the experts' perspectives, these factors—though not directly financial—serve as key enablers that support long-term agricultural success, community development, and environmental stewardship. This theme emphasizes how non-monetary elements contribute to shaping a sustainable agricultural model aligned with national goals and the broader vision of economic transformation. It emerged from the following six codes:

Food Security: Refers to ensuring consistent and sufficient access to nutritious food for the population, supported by stable and productive agricultural systems. The interviews revealed several indications of this code, for example, two, five and eleven interviews, respectively, indicated the following indications: "Economic benefits include increased yields, export opportunities, improved food security, and higher contribution to agricultural GDP", "While also factoring in their contribution to food security and environmental preservation" and "Consumers are increasingly valuing products that contribute to environmental sustainability and food security".

Rural Employment: Involves creating job opportunities in rural areas through sustainable farming practices, helping reduce poverty and improve livelihoods. The interviews revealed several indications of this code, for example, eight, ten and twelve interviews, respectively, indicated the following indications: "Sustainable agriculture plays a crucial role in food

security and rural employment, especially in newly reclaimed areas like the New Delta", "I provide policy recommendations to enhance cost efficiency, encourage economic diversification, and promote rural employment through inclusive farming models that support food security" and "Sustainable agriculture plays a pivotal role in stabilizing food production and creating job opportunities, especially for youth in rural areas, thereby supporting rural development".

Market Integration: Describes the process of connecting agricultural producers with local, national, and international markets to ensure efficient product distribution and fair pricing. The interviews revealed several indications of this code, for example, one, six and eleven interviews, respectively, indicated the following indications: "Economically, the integration of New Delta products into markets faces challenges such as supply chain inefficiencies and certification gaps.", "A strong market integration strategy is necessary to unlock this potential and ensure profitability" and "Strengthening policy frameworks to support these initiatives is also essential for successful market integration".

Policy Framework: Represents the importance of having clear, supportive, and stable government policies and regulations that promote and protect sustainable agricultural practices. The interviews revealed several indications of this code, for example, five, six and eleven interviews, respectively, indicated the following indications: "Addressing these through targeted investment and policy framework reform is critical", "A more robust policy framework supporting domestic production of sustainable inputs would reduce dependency on imports and promote economic diversification" and "To improve accessibility, policy frameworks should be streamlined to simplify application processes, and outreach programs should

be implemented to educate farmers about available financial incentives".

Ecological Restoration: Focuses on efforts to rehabilitate and preserve ecosystems within the New Delta region, ensuring that agricultural development is environmentally responsible. The interviews revealed several indications of this code, for example, five, eight and ten interviews, respectively, indicated the following indications: "Long-term benefits include soil regeneration, improved biodiversity, and reliable yields, making CSA practices ideal for long-term ecological restoration and profitability", "This supports both profitability and ecological restoration" and "Benefits include stable yields, reduced input costs, and enhanced ecological restoration, all of which support economic resilience".

Technological Innovations: Refers to the adoption and use of modern technologies—such as precision farming, irrigation systems, and digital tools—to improve efficiency, productivity, and sustainability in agriculture. The interviews revealed several indications of this code, for example, two, five and six interviews, respectively, indicated the following indications: "Modern technology helps reduce costs through automation, efficient irrigation systems, drones, and AI-based monitoring, which together enhance productivity and reduce waste", "With technological innovations, we aim to optimize these expenditures to improve overall economic feasibility" and "Technological innovations also play a key role here". Figure 3 Shows the mind map that emerged from NVivo analysis for theme of non-financial factors enhance the sustainable agricultural practices and its codes.

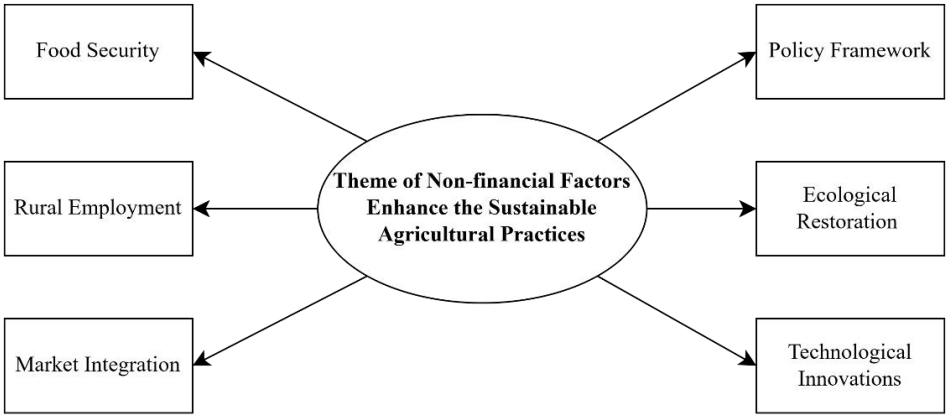

Figure 3: Theme of Non-Financial Factors Enhance the Sustainable Agricultural Practices and Its Codes

3. Theme of Financial Factors Enhance the Sustainable Agricultural Practices

The Theme of Financial Factors Enhance the Sustainable Agricultural Practices captures the experts' views on the essential role that financial mechanisms and economic tools play in supporting the long-term success of sustainable agriculture in Egypt's New Delta Project. According to the interviews, effective financial support can help overcome economic barriers, encourage investment, and ensure that agricultural practices remain viable and attractive to both small-scale and large-scale stakeholders. This theme focuses on how access to resources and financial planning can unlock the full potential of sustainable agriculture in the region. It emerged from six key codes:

Cost Efficiency: Refers to minimizing production costs while maintaining productivity, ensuring that agricultural activities are both affordable and sustainable over time. The interviews revealed several indications of this code, for example, six, ten and eleven interviews, respectively, indicated the following

indications: "Better digital outreach, mobile financing platforms, and local partnerships could improve cost efficiency and expand access to financial incentives", "The use of shared services and investment in efficient, climate-smart equipment boosts cost efficiency over time" and "However, reduced application frequency and better results lead to cost efficiency in the medium to long term".

Financial Incentives: Includes rewards or benefits—such as tax breaks or performance-based payments—that encourage farmers and investors to adopt sustainable practices. The interviews revealed several indications of this code, for example, five, seven and ten interviews, respectively, indicated the following indications: "High input costs can be a deterrent, but awareness of long-term profitability and access to financial incentives (like subsidies or grants) encourages sustained adoption", "The presence of financial incentives or guarantees can lower this rate" and "These financial incentives are critical in reducing upfront costs and supporting public-private partnerships aimed at sustainable development".

Subsidies: Represents government support in the form of financial assistance to reduce the cost burden of inputs, technologies, or services needed for sustainable agriculture. The interviews revealed several indications of this code, for example, one, seven and twelve interviews, respectively, indicated the following indications: "Subsidized credit improves access to capital at lower rates, and grants for technology adoption lower entry barriers to sustainable practices", "Farmers can benefit from government subsidies and targeted credit lines offered by agricultural banks" and "These impact sustainability unless offset by efficient practices or subsidies".

Credit Access: Focuses on the availability of loans or financing options for farmers and agribusinesses to invest in equipment, seeds, or infrastructure that support sustainable practices. The interviews revealed several indications of this code, for example, six, eight and ten interviews, respectively, indicated the following indications: “We mitigate it through bulk purchasing, shared distribution networks, and accessing credit or subsidies”, “Improving credit access through simplified procedures and expanding the role of public-private partnerships can significantly enhance rural employment and economic diversification” and “While credit access and subsidies are available, many smallholders face challenges such as limited financial literacy and complicated procedures”.

Public-Private Partnerships: Describes collaborations between government entities and private sector organizations to co-invest in agricultural projects, share resources, and drive innovation. The interviews revealed several indications of this code, for example, one, five and eleven interviews, respectively, indicated the following indications: “Addressing these high initial costs necessitates long-term financing models, such as blended finance arrangements or Public-Private Partnerships (PPPs)”, “Some public-private partnerships have also initiated green credit schemes to promote climate-smart agriculture” and “These include government-provided subsidies for adopting eco-friendly practices, low-interest loans facilitated through public-private partnerships, and credit access programs aimed at smallholder farmers”.

Profitability: Refers to the ability of sustainable agricultural ventures to generate consistent financial returns, making them economically attractive and competitive in the long run. The interviews revealed several indications of this code, for example, two, seven and twelve interviews, respectively,

indicated the following indications: "Higher yields lower per-unit costs and increase exportable surplus, which improves farm profitability and economic viability", "This involves considering profitability, risk management, and alignment with environmental realities like water scarcity" and "Benefits include higher quality produce, improved market access, better resilience to climate risks, and increased long-term profitability". Figure 4 Shows the mind map that emerged from NVivo analysis for theme of financial factors enhance the sustainable agricultural practices and its codes.

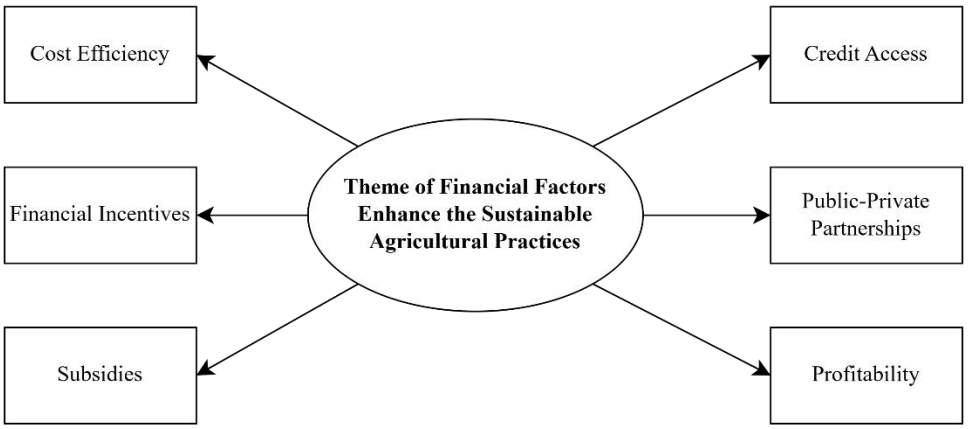

Figure 4: Theme of Financial Factors Enhance the Sustainable Agricultural Practices and Its Codes

4. Theme of Challenges Face Sustainable Agricultural Practices

The Theme of Challenges Facing Sustainable Agricultural Practices reflects the concerns raised by economic experts regarding the major obstacles that threaten the success and sustainability of agricultural development in Egypt's New Delta Project. This theme focuses on environmental and resource-related issues that could hinder long-term productivity, reduce the effectiveness of agricultural strategies, and limit economic

gains. Addressing these challenges is essential to ensuring that the New Delta initiative fulfills its promise of sustainable agricultural transformation. This theme emerged from the following three codes:

Climate Change: Refers to the negative impacts of shifting weather patterns—such as rising temperatures, irregular rainfall, and extreme weather events—that affect crop yields and agricultural planning. The interviews revealed several indications of this code, for example, three, six and ten interviews, respectively, indicated the following indications: "However, they last longer and are more effective under challenging climate conditions", "We factor in the cost of capital, inflation, and project risk—particularly related to climate change and market volatility" and "Sustainable agriculture ensures reliable food production even under climate change pressures, while also generating year-round employment in farming, processing, and advisory roles".

Water Scarcity: Describes the limited availability of water resources needed for irrigation and farming, posing a serious constraint to agricultural expansion and sustainability in the New Delta region. The interviews revealed several indications of this code, for example, seven, ten and eleven interviews, respectively, indicated the following indications: "This involves considering profitability, risk management, and alignment with environmental realities like water scarcity", "These also mitigate soil degradation and water scarcity" and "While the initial costs may be higher, the ongoing expenses are often offset by increased efficiency and resilience to environmental stresses like water scarcity and soil degradation".

Soil Degradation: Involves the decline in soil quality due to factors like erosion, salinity, and nutrient loss, which reduces land productivity and challenges long-term agricultural success.

The interviews revealed several indications of this code, for example, five, ten and eleven interviews, respectively, indicated the following indications: "Economic viability in this context involves analyzing the return on investment of sustainable methods under constraints like water scarcity and soil degradation", "Climate change, water scarcity, and soil degradation also add complexity, requiring high upfront investments in technological innovations" and "While the initial costs may be higher, the ongoing expenses are often offset by increased efficiency and resilience to environmental stresses like water scarcity and soil degradation". Figure 5 Shows the mind map that emerged from NVivo analysis for theme of challenges face sustainable agricultural practices and its codes.

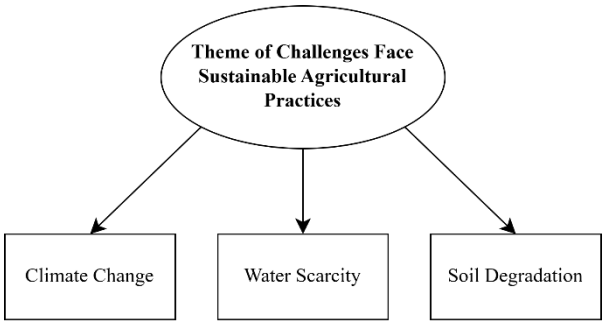

Figure 5: Theme of Challenges Face Sustainable Agricultural Practices and Its Codes

DISCUSSION AND CONCLUSION

The purpose of conducting interviews with twelve economic experts involved in Egypt's New Delta Project was to gain in-depth insights into the economic opportunities and challenges facing sustainable agricultural development in this strategic national initiative. Thematic analysis of the interviews revealed four major themes, each offering critical perspectives that align

with the project's broader aim of promoting a resilient, productive, and forward-looking agricultural sector.

The first theme, Economic Sustainability, highlights the core economic foundations necessary for the long-term viability of the New Delta Project. Experts emphasized that economic diversification, viability, resilience, and feasibility are interrelated pillars that ensure sustainable growth. By reducing dependence on single crops, strengthening the profitability and adaptability of agricultural practices, and ensuring that economic models are practical and scalable, this theme presents a clear roadmap for building a robust agricultural economy in the region.

The second theme, Non-financial Factors Enhance the Sustainable Agricultural Practices, underscores the importance of integrating social, institutional, and environmental elements into agricultural planning. Key codes such as food security, rural employment, market integration, policy frameworks, ecological restoration, and technological innovation suggest that non-financial aspects are not peripheral but central to the success of sustainable agriculture. These factors contribute to systemic stability, social inclusion, and environmental responsibility—elements that are vital for achieving the New Delta's long-term strategic objectives.

The third theme, Financial Factors Enhance the Sustainable Agricultural Practices, reinforces the role of financial support systems and economic incentives in enabling sustainable agriculture. The experts highlighted the need for cost efficiency, access to financial incentives and subsidies, credit facilities, public-private partnerships, and assured profitability. These financial enablers are necessary to lower the entry barriers for farmers and investors, encourage innovation, and sustain growth in a highly competitive and resource-sensitive sector.

Finally, the fourth theme, Challenges Facing Sustainable Agricultural Practices, identifies key environmental constraints that must be addressed proactively. Climate change, water scarcity, and soil degradation were cited as critical threats that could undermine the effectiveness and resilience of agricultural initiatives in the New Delta. These challenges demand integrated responses, including climate-smart agriculture, water management innovations, and sustainable land use practices. Figure 6 summarizes the results of the thematic analysis that emerged from NVivo program.

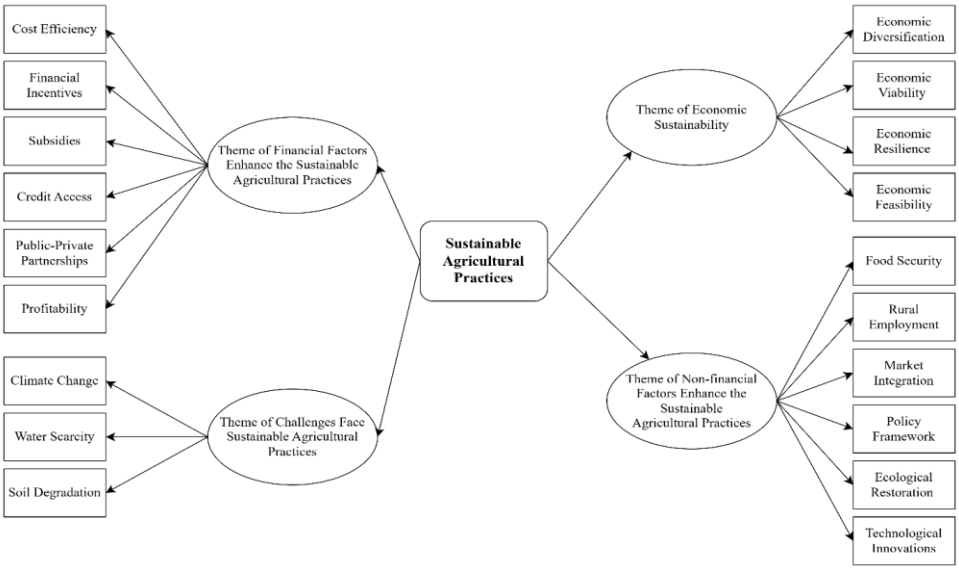

Figure 6: Summarized Mind Map

In conclusion, the findings of this thematic analysis reveal a nuanced and comprehensive view of sustainable agriculture in Egypt's New Delta Project. They suggest that achieving economic sustainability requires a multi-dimensional approach—one that balances financial investment with social equity, technological advancement, and environmental preservation. The perspectives shared by economic experts

highlight both the promise and the complexity of building a sustainable agricultural future in this transformative national project. The next stage of the report will explore these themes in further detail, unpacking the codes and subthemes that give depth to each of these insights.

RESEARCH RECOMMENDATION

The findings of this study yield several critical recommendations for economic policymakers committed to advancing sustainable agriculture within Egypt's New Delta Project.

First, **promoting economic diversification and viability** must be prioritized. Policymakers should support the adoption of diversified cropping systems and the development of value-added agri-industries that enhance economic resilience. Incentive schemes, coupled with targeted technical assistance, can help mitigate the risks associated with market volatility and climate change, ensuring sustained agricultural profitability.

Second, it is imperative to **integrate non-financial dimensions**—including social, institutional, and environmental factors—into agricultural policy design. Elements such as rural employment, food security, policy coherence, market connectivity, ecological restoration, and technological innovation are essential for achieving holistic sustainability. Therefore, a multi-stakeholder governance model involving public institutions, private sector actors, and civil society should be institutionalized to foster inclusive development and systemic stability.

Third, **financial support mechanisms must be enhanced** and tailored to the specific needs of farmers and agribusinesses

operating in the New Delta. Expanding access to credit, providing well-structured subsidies, and fostering public-private partnerships are critical strategies. Ensuring transparency, equity, and administrative efficiency in financial incentive programs will lower entry barriers for small and medium-sized enterprises and stimulate long-term investment and innovation.

Fourth, addressing the region's **critical environmental constraints—particularly climate change, water scarcity, and soil degradation—requires a strategic commitment to climate-smart agriculture**. Policymakers should facilitate the diffusion of adaptive technologies, efficient water management systems, and sustainable land-use practices. Parallel investments in agricultural research, farmer training, and extension services are essential to building local capacities and encouraging the uptake of sustainable innovations.

Finally, **developing integrated monitoring and evaluation (M&E) systems** is crucial. These systems should go beyond financial indicators to encompass social and environmental outcomes, thereby providing a robust framework for tracking progress toward national and international sustainability goals.

In sum, a balanced and interdisciplinary policy approach—grounded in economic insight and aligned with environmental and social imperatives—is essential for the long-term success of sustainable agriculture in Egypt's New Delta Project.

RESEARCH LIMITATION AND SUGGESTION FOR FUTURE RESEARCHERS

While this study offers valuable insights into the economic dimensions of sustainable agriculture within Egypt's New Delta Project, several limitations should be acknowledged to contextualize its findings and guide future inquiry.

First, the research is based on a relatively small purposive sample of twelve expert interviews. Although these participants provided rich and relevant insights, the sample size may not fully capture the diversity of perspectives across all stakeholder groups involved in or impacted by the project. Notably, the voices of farmers, private investors, and local community members were not directly represented, which may limit the generalizability of the findings and bias them toward technical and managerial viewpoints.

Second, the study's focus was limited to economic experts. While their perspectives are crucial for understanding the economic viability and policy implications of sustainable agriculture, the absence of multidisciplinary input—particularly from environmental scientists, social development practitioners, agricultural engineers, and extension specialists—restricts the scope of analysis. A more integrative, cross-sectoral perspective could yield a more holistic understanding of the complex interplay between economic, environmental, and social dimensions.

Third, although thematic analysis was methodologically appropriate for uncovering patterns within qualitative data, it inherently involves a degree of subjective interpretation. Despite employing NVivo software to enhance analytical rigor

and transparency, researcher bias cannot be entirely excluded from the coding and theme development processes.

To address these limitations, future research should adopt **broader and more inclusive sampling strategies**, incorporating diverse stakeholder groups such as smallholder farmers, agribusiness owners, local residents, and non-governmental actors. This would ensure a more representative understanding of how sustainable agriculture initiatives are experienced on the ground.

Moreover, **mixed-methods approaches**—combining qualitative interviews with quantitative assessments—are recommended to triangulate findings and capture both depth and measurable outcomes. In particular, longitudinal studies tracking economic, social, and environmental indicators over time would be invaluable in evaluating the long-term effectiveness and sustainability of the New Delta Project.

Finally, **comparative research** involving similar large-scale agricultural projects in other arid or semi-arid regions could offer useful benchmarks and transferable lessons. Such cross-contextual analysis would enrich the global discourse on sustainable agricultural transformation and inform more adaptive, evidence-based policymaking in Egypt and beyond.

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