Sustainable Agriculture for Food Security: Conceptual Framework and Benefits of Digitalization

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Abstract The article is intended to answer the research question of whether today's agriculture and food systems can meet the needs of a global population that is projected to reach more than 9 billion. Can we increase the required production, even as the pressures on already scarce land and water resources and the negative impacts of climate change intensify? The study shows that a transformed agribusiness should evolve into an enticing movement that contributes to the alignment and achievement of financial, natural, and social manageability goals. Through cutting-edge calculations and clever computerized innovations, farming business measurements at all levels and between all value chain partners are expected to be linked. Business situations such as brilliant and ideal water system and assurance, food control and safety, soil and variety insurance, astute homestead management, and creature creation should be recognized through such businesses, all to achieve natural, financial, and social sustainability. Additionally, increased adaptability of horticultural property, a new approach to work and participation, and a strengthened culture should allow for variation in the event of anticipated disruptions in financial, natural, and social streams.

Keywords Sustainable agriculture · Food security · Digitalization · Digital economy · Agribusiness

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1 Introduction

Agricultural production more than tripled over the last decade, partly owing to productivity-enhancing technologies and a significant expansion in the use of land, water, and other natural resources for agricultural purposes. The same period witnessed a remarkable process of industrialization and globalization of food and agriculture. Food supply chains have lengthened dramatically as the physical distance from farm to plate has increased. The consumption of processed, packed, and prepared foods has grown in all but the most isolated rural communities [1].

Nevertheless, persistent and widespread hunger and malnutrition remain a huge challenge in many parts of the world. The current rate of progress will not be enough to eradicate hunger by 2030, and not even by 2050. At the same time, the evolution of food systems has responded to and driven changing dietary preferences and patterns of overconsumption, which is reflected in the staggering increases in the prevalence of overweight and obesity around the world. Expanding food production and economic growth have often come at a high cost to the natural environment [2, 3].

Looking ahead, the core question is whether today's agriculture and food systems can meet the needs of a global population that is projected to reach more than 9 billion. Can we increase the required production, even as the pressures on already scarce land and water resources and the negative impacts of climate change intensify? The consensus view is that current systems are likely capable of producing enough food, but inclusively and sustainably will require significant transformations.

2 Materials and Methodology

Sustainable Agriculture for food security is considered a scientific concept in the works of [4–6]. Conceptual framework and benefits of agriculture digitalization formulated in the studies of [7–9].

Historically, agricultural techniques were evaluated using a small number of models, including benefit yields and ranch usefulness. Nowadays, agriculture is considered sustainable when it can meet the current and future demands without jeopardizing financial, natural, social, or political requirements. Sustainable Agriculture is one translation that focuses on specific types of innovation, most notably procedures that reduce reliance on nonrenewable or environmentally damaging data sources.

Agricultural sustainability goes beyond a particular cultivating framework. In horticultural frameworks, supportability is defined as the framework's ability to cradle shocks and stresses while remaining productive. It refers to the capacity to adapt and change in response to changing external and internal conditions. The calculated boundaries have evolved from an initial emphasis on ecological factors to include financial and then more extensive social and political metrics. The primary goal is to minimize negative natural and human welfare externalities, costs, or benefits that affect a party that did not choose to cause them, to enhance and maximize the value of the local biological system's assets and conserve biodiversity. Subsequent concerns include a greater appreciation for horticulture's beneficial environmental externalities. Reasonable agriculture not only produces food and other marketable goods but also provides public goods such as clean water and flood protection.

Financial perspectives on horticultural viability seek to assign a monetary value to natural resources and to include a longer time horizon in economic analysis. Additionally, they include sponsorships that promote resource depletion or out-of-step competition with other frameworks for creation. Agrarian supportive frameworks may have various beneficial side effects, including assisting in the development of average capital and reinforcing social capital.

Additionally, this concept does not imply making decisions about technological advancements or practices based on philosophical concepts. If an innovation aims to increase utility without causing undue harm to the environment, it may generate various supportability benefits. In this regard, critical sustainability standards rely on reconciliation and biological cycles in food production, such as predation, supplement cycling, parasitism, and nitrogen obsession. The elimination of non-endless data sources that is detrimental to the environment or the well-being of ranchers and shoppers. Additionally, it is based on the concept of maximizing ranchers' knowledge and abilities, thereby increasing their independence and displacing expensive external data sources with human resources. Finally, the concept is based on individuals collaborating to address common horticultural and common asset issues such as watershed, water system, and forest management.

3 Results

The concept of sustainable development takes into account economic, biological, and social factors. If appropriate strategies for estimating these various segments are available, horticulture can make reasonable progress. There are currently several approaches to quantifying Sustainable Agriculture using indicators and thus making it implementable on an individual ranch in a horticultural setting.

To determine the current contribution of digitalization to sustainable agricultural development and food security, statistics on digitalization and sustainability of agriculture in 2020 in the leading countries in terms of agricultural sustainability were collected (Fig. 1).

According to Fig. 1, the highest level of digitalization is observed in Sweden (95.146 points) and the Netherlands (92.567 points), and the highest agricultural sustainability is in Norway (73.5 points) and Finland (73.2 points). Correlation analysis of data from Fig. 1 revealed a weak connection between the considered statistical

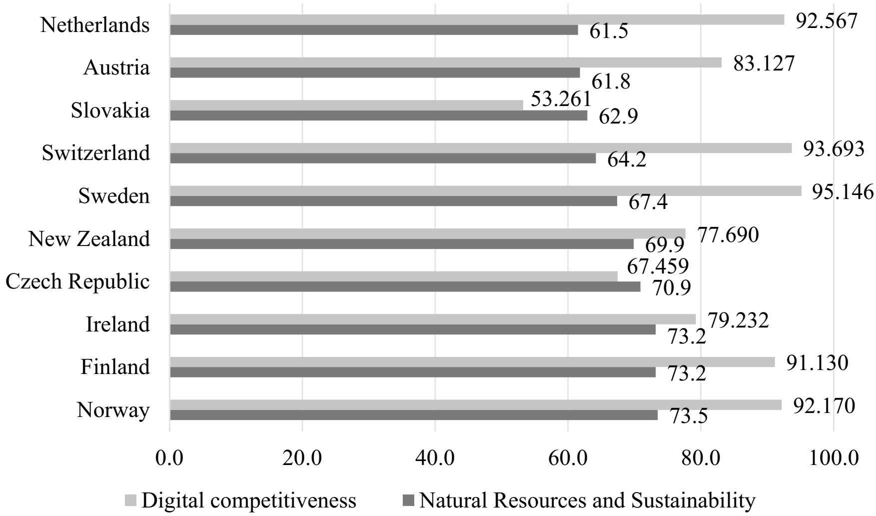

Fig. 1 Statistics of digitalization and sustainability of agriculture in 2020, scores 1–100 *Source* built by the authors based on materials from [10, 11]

indicators—the correlation was 9.63%. Consequently, digitalization currently makes little contribution to sustainable agricultural development and food security.

When surveying cultivating frameworks, the productivity of various rural land uses, expressed as yield per unit area, should be a critical indicator. The information base is adequate at all scale levels. Regardless, detailed data on location and, in an ideal world, weather-specific yield potential are required for comprehension, which must be accumulated in either information banks or yield models. Additionally, yield levels must be easily decipherable whenever data on development practices, precisely the extent of treatment and the use of plant protection products, are discovered. It is the most effective method for determining whether the yield execution to cost ratio is acceptable [12].

At all levels of perception, the example of the revolution and the recurrence of development can be viewed as similarly appropriate indicators. Models don't need to portray themselves in mind-boggling ways. Acquiring information, recognizing logic, and translating the recurrence of development are all nearly effortless. Additionally, the two pointers can provide information about biodiversity.

Hereditary variety and selection decision-making can be used as fundamental indicators of manageability. In any case, they should be located in the pivot example and development recurrence pointer chain. Although the cost of obtaining information may be prohibitively high depending on the size of perception, it is typically accomplished using data provided by plot card lists or the rural exchanging local area.

Adjusting supplements or compost is a critical indicator of a farm's viability. Proper preparation is necessary for high utility and yield quality. Simultaneously, treatment is essential for maintaining and expanding soil diversity [13]. The examination of supplement and manure changes will also provide information on soil fertility advancement and aid in evaluating natural effects. In terms of site and execution, evaluation could provide insight into the effectiveness of supplement inputs and the anticipated threat to the climate.

The energy assessment of cultivating frameworks is a focal point with a high degree of similarity and applicability. Net energy acquisition and/or energy productivity can be used as critical indicators for energy appraisal, with energy acquisition used to evaluate execution and energy proficiency used to evaluate a framework's natural effect. At all scales, the information base based on yield measurements and information on manufacturing techniques is sufficiently precise. As with the efficiency pointer, specific data on the area explicit yield potential must be gathered either through information banks or through yield models to decipher the information.

The resource-based view of a farm can be depicted by computing the benefit of the various creation measures, establishing commitment edges, and selecting the ideal explicit power. The ranch-level information base is fundamentally excellent. Regardless of whether the rules are at the territorial or public level, distinguishing proof of proficiency is risky. A determination of edge esteems only possible with territorial and homestead type-explicit correlation data.

With the reservations depicted above, results can be applied to all boundaries referenced thus far on a fundamental level. However, it should be noted that a reasonable translation may be possible if the entire framework is broken down and the collaborations between various development practices from one perspective and the site-explicit yield potential from the other are adequately reflected.

Horticulture can now be viewed as the foundation for natural, economic, and social sustainability. Significant methodology, constraints, technological advancements, client centricity, hierarchical culture, and development will all play a role in this, and one of the most valuable assets will be advanced information, which is viewed as a critical factor in rural development.

Most importantly, we must begin with horticulture's most frequently referenced primary asset: information. The agricultural industry generates enormous amounts of data that are currently understudied and underutilized. Later on, it is customary to combine produced agrarian data with open data on climate, spatial data, and other data, resulting in advanced calculations useful for dynamic, programmed measure control and ensuring management and security in horticultural activities. For example, in the production of animals or leafy foods, field observations of soil dampness, pH, precipitation, growth rate, and development can assist ranchers in determining the optimal method of preparation, water system, or other business cycles such as collecting, security, and so on. The application of such advanced calculations would contribute to the conservation of water assets in the water system, as well as to the reduction of pesticide, herbicide, and manure use, as well as to time and cost savings.

Additionally, one of the critical issues addressed will be the security and confirmation of soil biodiversity and manageability. The future period will be defined by the development of clever policies that attempt to address a portion of these issues. For instance, the role of soil in agriculture is critical, as it serves as a vital dynamic link in the interaction that is the basis of life on Earth. The establishment of a sophisticated biomonitoring framework capable of identifying and eliminating sources of contamination to maintain maximum biological potential is critical and significant not only for soil quality but also for biodiversity conservation and human health. Concerns about manageability will accelerate the development of business arrangements based on computerized innovations aimed at increasing the productivity of biomass supply chains, from precise development to prudent stockpiling and coordination to optimal end-user use. Additionally, the use of natural pesticides will become more closely linked to agricultural cycles, allowing for the preservation of healthy soil conditions and reducing soil contamination, all of which benefit human health, land use, and financial proficiency [14].

Apart from that, the critical direction, advancement, and traditional culture, as well as the limit, client centricity, and focus on all partners, are not insignificant. Later on, an adequate emphasis has been placed on ensuring manageability through agribusiness approaches and objectives. Nonetheless, all partners are accountable for cultivating advancement, participation, and a hospitable environment within the agricultural sector [15]. Agribusiness can benefit from advanced tools and platforms for communication, experience exchange, information distribution and exchange, product development, and product development. This can aid in expanding into new business sectors, meeting the needs of industries where certain rural items are scarce, and developing imaginative things and the foundation for business participation, all of which can eventually contribute to the turn of events and development of supportability. For instance, if certain rural items are scarce, manufacturers can ensure financial viability by providing individuals with things that may not be readily available to them.

Additionally, numerous specialized farming products can be developed to address the needs of various business sectors. Ducks are an example of a model. Duck meat is widely consumed in the European market, whereas duck legs are frequently used for food and duck feathers for other creative purposes in the Eastern world. There are numerous such items whose development can address the needs of various business sectors while also ensuring sustainability, which will be accomplished through the use of stages and associated value chains.

4 Conclusion

Global issues such as environmental change and dangerous atmospheric depletion, extreme climate disasters, and unexpected disruptions are becoming an increasing concern for the economy and private frameworks. This is precisely why it is necessary to investigate novel, advanced conceivable outcomes of technological advancements. Additionally, global pioneers' approaches address this issue and aim to develop event reversal and manageability development methodologies. Sustainability is a concept that emphasizes the three fundamental perspectives of financial, natural, and social sustainability. Horticulture is particularly relevant in these three perspectives, as it is one of the few activities that can directly affect them, either positively or negatively. This concept stimulated research into the impact of horticulture on manageability and the role of computerized innovations in achieving supportability in an agribusiness setting.

The focus will now be on the needs of the entire environment, including ranchers and manufacturers from various industries, policymakers and state governments, and any remaining partners. The primary asset will no longer be information, but rather advanced calculations and information that will aid in the management of rural cycles. Computerized advancements will be focused on monitoring and tending to environmental change and dangerous atmospheric devastation, as well as on responding to radical climate changes and other unsettling economic influences. A transformed agribusiness should evolve into an enticing movement that contributes to the alignment and achievement of financial, natural, and social manageability goals.

Through cutting-edge calculations and clever computerized innovations, farming business measurements at all levels and between all value chain partners are expected to be linked. Business situations such as brilliant and ideal water system and assurance, food control and safety, soil and variety insurance, astute homestead management, and creature creation should be recognized through such businesses, all to achieve natural, financial, and social sustainability. Additionally, increased adaptability of horticultural property, a new approach to work and participation, and a strengthened culture should allow for variation in the event of anticipated disruptions in financial, natural, and social streams.

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