

ATTAINING A COMPETITIVE EDGE IN THE AGRIFOOD SYSTEM: INTEGRATING REGENERATIVE STRATEGIES AND DIGITAL TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

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Abstract. The article addresses the contemporary challenges facing the agrifood sector in sustaining competitive advantages through the integration of regenerative strategies and digital technologies. Population growth, inadequate conditions for ensuring food security, cases of hunger and poverty in rural regions, and natural disasters underscore the need for novel development paradigms. Sustaining sustainable competitive advantage relies on the accumulation of valuable resources, with digital technologies occupying a pivotal position. Despite historically prioritizing sustainable development, agribusiness enterprises have not fully addressed urgent environmental issues such as mitigating global warming. Regenerative agribusiness seeks to restore natural resource properties and establish ecologically oriented agrifood systems by blending traditional and innovative technologies. Ambiguities in assessing the outcomes of agribusiness enterprises' environmental initiatives stem from unclear regulations governing regenerative agribusiness technologies and the lack of relevant standards. Departing from traditional entrepreneurial paradigms, regenerative agrifood systems align with stakeholders' long-term goals, including reducing the greenhouse effect, waste management, biodiversity conservation, soil improvement, water resource management, and promoting socio-economic development in local communities. Utilizing innovative regenerative strategies and valuable resources, particularly digital technologies, enables enterprises embracing regenerative entrepreneurship principles to reinforce their sustainable competitive advantages. Internet of Things, automation and robotization, artificial intelligence, traceability, and Big Data are identified as prominent innovative solutions with considerable impact on the agrifood value chain. Transitioning established business models into regenerative ones necessitates meticulous data processing, while the convergence of innovative regenerative strategies with digital technologies sets the stage for maintaining sustainable competitive advantages.

Keywords: agribusiness, regenerative strategies, digital technologies, regenerative value chains.

1. Introduction

The development of modern agrifood systems is heavily focused on achieving short-term rewards reflected by financial indicators. At the same time, the prospects of increasing the population of the planet, the lack of conditions for global food security, unsolved problems of hunger and poverty in rural communities, increased negative impact on nature and the destructive influence of climate changes necessitate the search for new development paradigms of the agrifood systems based on innovative approaches and high environmental standards. Amid rising environmental pollution, persistent trends of increasing greenhouse gas emissions causing dramatic climate degradation point to the importance of stimulating changes in approaches to entrepreneurial activities, particularly within agribusiness.

Bricas (2019) points out the three main objectives for food systems: (a) ensuring food security and improving nutrition; (b) promoting inclusive development; and (c) creating a sustainable environment while tackling climate change. The current farm and food businesses achieved a high level of productivity based on modern technologies. However, the real image of agribusiness relates particularly to extensive wastes, land pollution, intensive usage of non-renewable resources, orientation on the long-distance transportation of agricultural commodities, food scares as a result of complex sourcing supply chains and unreliable system of traceability. That is why agribusiness companies are seeking alternative solutions to address the current challenges to reflect consumer demand and improve competitive positions.

In the pursuit of competitiveness, it is crucial to consistently expand and safeguard market share at both national and global arenas. This involves innovative management, efficient resource utilization, participation in the operations of integration entities, implementation of focus strategy, achieving economies of scale, product differentiation, accumulation of core competences, and leadership in both cost and quality (Christensen 2001; Porter 1985). Recognizing valuable resources as a cornerstone is fundamental to maintaining competitive advantage (Barney 1991). Enterprises rely on innovative technologies and management expertise as their distinctive resources.

Martín-de Castro and Amores-Salvadó (2024), emphasizing the importance of disruptive business models and solutions in current business climate, propose introduction of the innovative regenerative strategy that effectively connects climate science with the domains of management studies. Hahn and Tampe (2020) rationalized their approaches to regenerative strategies of restoration, preserving and life-enhancing. Restoring the original natural futures of soil and landscape is not feasible. The concept of regenerative agribusiness embraces a holistic approach with focus on effects in respect to people and the planet, combining traditional business methods and technological innovations to mitigate the impact of global warming, restore natural resources, and optimize agrifood systems.

Is regenerative agribusiness a more promising alternative to sustainable practices? Can digital technologies bolster firms in implementing regenerative strategies for attaining sustainable competitive advantage? Following that, we will address these questions and explore solutions within the context of a paradigm for advancing regenerative agrifood systems.

2. Emphasizing regenerative agribusiness as a solution to environmental challenges

The growth of the world market is fueled by increasing incomes and the expanding global population, leading to heightened demands for raw materials and food products. Traditionally, industrial energy-intensive technologies were hailed as the pathway to sustainable economic growth. However, these very technologies contribute to air pollution, land degradation, soil erosion, and water quality deterioration, thus undermining the quality of agribusiness products and impeding sustainability.

Alongside industry and other sectors, agriculture also plays a significant role in shaping climate change. Within a linear economy framework for agrifood systems, there is a notable increase in agricultural waste generation, prompting the need for disposal strategies. In developing countries, post-harvest and processing stages are accountable for over 40% of food losses, whereas in industrialized nations, more than 40% of food losses happen at retail and consumer levels, with economic, social, and ecological repercussions. (Gustavsson 2011). The crux of the circular economy approach is to uphold the value of commodities by maximizing their durability and returning them to the production cycle once their purpose is fulfilled, with a focus on minimizing waste generation, shrinking material and energy loops (Geissdoerfer et al. 2017). The circular economy model reflects fundamental next principles (Gryshova and Nesterova 2021):

- Waste minimization and lean logistics,
- Sustainable utilization of natural resources,
- Promotion of responsible consumption practices.
- Encouraging partnerships among businesses, society, and government for implementation of circular economy initiatives.
- Establishment of regulatory, legal, organizational, and economic frameworks to enable adoption of circular economy principles.

Central to the sustainable development model is the effort to integrate substantial economic progress with the resolution of various environmental and social dilemmas. Outlined below are the strategies for establishing sustainable agrifood systems (Notarnicola et al. 2012, Pretty 2012):

- Ceasing the expansion of agricultural land,
- Enhancing food production without expanding agricultural land by optimizing crop yields,
- Selecting crop varieties and livestock breeds that demonstrate high productivity while minimizing input requirements.
- Maximizing the utilization of agro-ecological processes.
- Minimizing resource utilization without diminishing quantity and quality of food,
- Implementing changes in consumption patterns – dietary adjustments and minimizing environmental impacts of non-food uses of plant-based and animal products.
- Restricting the use of technologies, resources, and practices that cause environmental damage.

- Employing human and social capital to develop innovative approaches to address common landscape-scale problems.
- Steering system management towards resolving challenges related to greenhouse gas emissions, water pollution, carbon sequestration, biodiversity preservation, and the protection of plants and animals.

Despite the declaration of programs by numerous firms and organizations at different levels to implement sustainable development principles, the desired outcomes were not reached. The challenge of global warming persists, together with other ecological issues, underscoring the need for concrete steps to ensure effective solutions.

Mang and Reed (2012) represent the concept of regenerative design as a set of methodologies and approaches focused on nurture regeneration, rather than depletion. Regenerative agribusiness alleviates the detrimental effects of intensive industrial technologies by integrating traditional farming methods with technological innovation to restore natural resource properties and establish an ecologically oriented agrifood system.

There is a necessity for policies that advocate for shifts from sustainable to regenerative food system to enhance food production oriented on (Schulte et al. 2022; Reznik et. al 2020, 2022):

- Reduction of the use of nonrenewable and unsustainable resources.
- Integration of plant and livestock systems.
- Extensive adoption of crop rotation, cover crops, and green manure.
- Improvement of long-term pasture quality by rotational grazing.
- Minimization of soil disturbance and utilization of plant residues.
- Cultivation of perennial crops to enhance soil structure.
- Reduction of soil disturbance and improvement of its structure.
- Application of natural methods for controlling diseases and pests in agriculture.
- Adoption of carbon footprint-reducing technologies.

There's potential to distinguish process-oriented and outcome-based definitions of regenerative agriculture (Newton et al. 2020). Ambiguity arises in assessing the activities of agribusiness enterprises due to the absence of quality standards and grades, impacting consumer confidence in their products and services.

According to Precedence Research, the global regenerative agriculture market size was valued at USD 975.20 million in 2022, and it is projected to increase in value to around USD 4,290.92 million by 2032, with a CAGR of 15.97% from 2023 to 2032 (Precedence Research 2023). The concept of regenerative agriculture lacks a universally agreed model, and expert opinions on the prospects for the development of this industry exhibit notable discrepancy. Yet, in spite of the challenges outlined above, the advancement of regenerative agriculture notably enhances the ethical dimension of entrepreneurial engagements. By discarding conventional paradigms and integrating innovative technologies, regenerative agrifood systems can reflect stakeholders' long-term objectives: mitigating the greenhouse effect, fostering biodiversity, enhancing soil conditions, optimizing water resource management, establishing regenerative value chains, preserving landscape diversity, and promoting socio-economic development of local communities (Fig. 1).

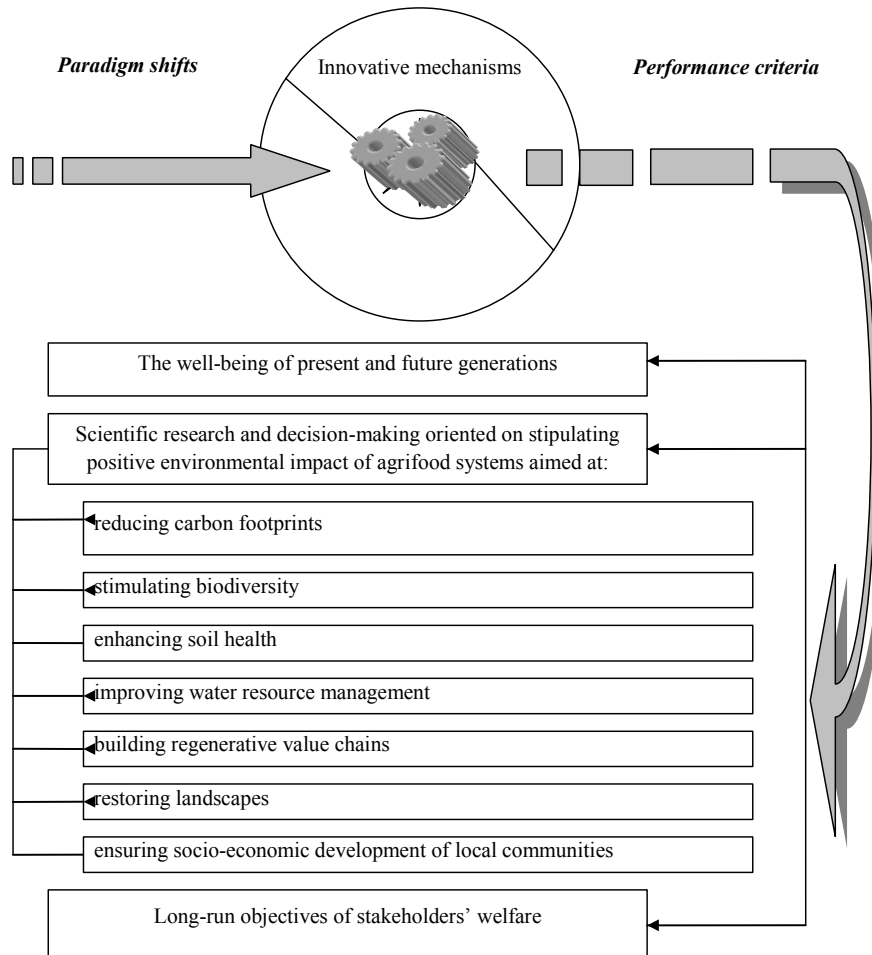


Fig. 1 Achieving long-run objectives of stakeholders' welfare through innovative mechanisms aimed on developing regenerative agrifood systems

The welfare of future generations is dependent on more than just current profits; it also requires thorough processing of raw materials, waste minimization, and prudent management of natural resources.

3. Digital technologies that bolster firms in implementing regenerative strategies in agribusiness

There is no simple way to convert conventional business model into regenerative one, and innovative technologies ought to be applied for such purposes. Within agribusiness, digital farming represents the incorporation of digital technologies like smart drones, in-field soil sensors, GPS and GIS, and other methods that empower entrepreneurial decision-making processes. Pesce et al. (2019) distinguished innovative solutions with high impact (Internet of Things, automation and

robotization, artificial intelligence, traceability, and Big Data), with medium impact (blockchain, GNSS, virtual reality), and low impact on the agrifood value chain (broadband networks, information and communication technologies, platforms for e-business).

Combining digital technologies and innovative regenerative strategies for managing agrifood systems may be crucial for establishing a sustainable competitive advantage (see Fig. 2).

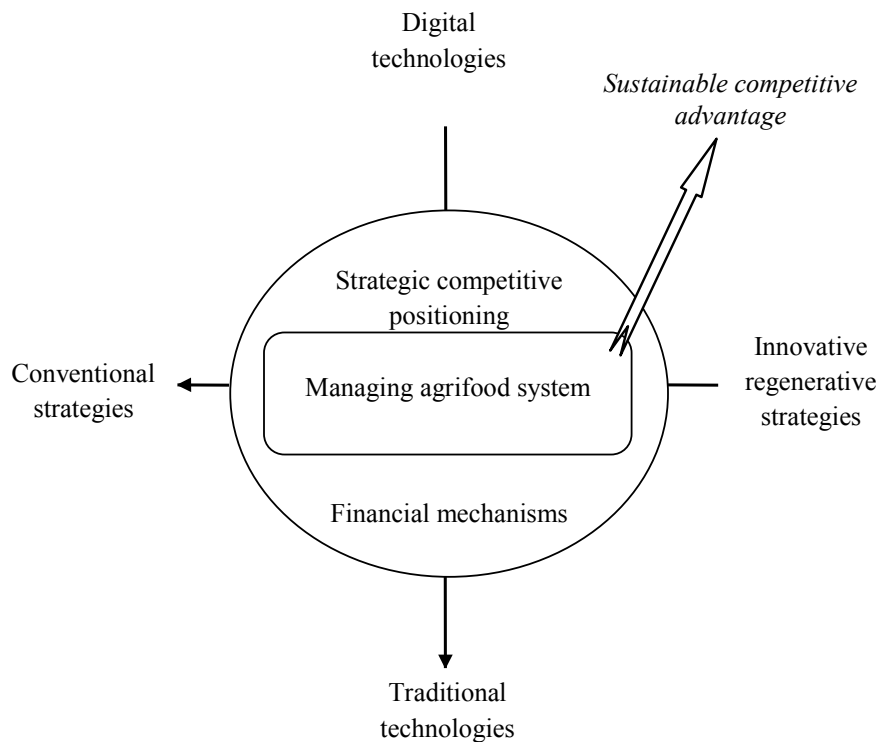


Fig. 2 Creating sustainable competitive advantage through managing agrifood system on the basis of digital technologies and innovative regenerative strategies
Source: Developed from Pamela Mang and Bill Reed (2012)

Intelligent information systems have been used to improve technological processes in crop production, such as sowing, cultivating crops, harvesting. In livestock production robots can be applied for formulating livestock feeding rations, milking cows, identifying diseases.

IoT applications in agribusiness is a prerequisite for achieving (Sadiq et al., 2014):

- efficiency of resource and risk management,
- reduction in operational costs,

- increased profitability,
- sustainability,
- food safety,
- reduced environmental footprint.

The shift to 'climate-smart' regenerative agribusiness encompasses political, practical, and personal dimensions (Gosnell et al. 2019). The following stages of the mechanism for the introduction of digital technologies in agribusiness can be identified: monitoring the general trends in digitalization, assessment and analysis of the economic environment when introducing digital tools, structuring the information received and preparing for the introduction of such technologies in practice, search for financial resources for implementation of digital technologies, monitoring the process of strategy implementation and taking corrective measures, assessment of the impact of digital technologies on performance, evaluation of the obtained results and their comparison with the set indicators (Nedilska and Oleniuk 2020).

Within "smart" regenerative agribusiness, the integration of automated decision-making systems, robotization, and ecosystem restoration technologies is paramount. Considering the need to process substantial amounts of information when implementing regenerative strategies, digital technologies present significant prospects for agribusiness firms to bolster their competitive advantages through automation and innovative management technologies.

4. Conclusions

The exacerbation of today's economic, social, and environmental dilemmas necessitates a reorientation of entrepreneurial activities from short-term profit objectives to long-term public welfare goals. Meeting consumer demands and maintaining competitive advantages drive the exploration of innovative technologies and the accumulation of valuable resources. In light of the planet's growing population, the development of regenerative agribusiness emerges as a critical solution to the ongoing challenge of supplying consumers with quality food products on a sustained basis.

Expanding the array of sustainable and circular development paradigms, the notion of regenerative agribusiness relies on melding traditional and innovative technologies that foster positive socio-economic and environmental impacts. The absence of a widely agreed-upon definition for regenerative agribusiness results in varying assessments of its developmental potential and undermines consumer trust in the technologies utilized for produced commodities. Integrating digital technologies with innovative regenerative strategies is imperative in managing agrifood systems to attain sustainable competitive advantages.

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