

Green Technologies and Sustainability: The Role of Digital Leadership in Agricultural SMEs

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Abstract. In a global context marked by the transition to a more sustainable economy, this study investigates how green technologies, supported by digital leadership, contribute to strengthening organizational sustainability, particularly within the agricultural sector. Adopting a qualitative approach, the study relies on empirical data collected through an interview with the CEO of an innovative Tunisian company specializing in smart irrigation solutions. Thematic analysis reveals that the integration of green technologies not only enhances the productivity and profitability of farms, but also preserves natural resources and promotes environmentally friendly practices. The role of the manager, characterized by a proactive vision, adaptability, and a commitment to sustainability, proves to be decisive in guiding the company towards a successful ecological transition. Furthermore, the study identifies several obstacles, such as the initial cost of technologies, technical complexity, and resistance to change, while emphasizing the importance of strategic and institutional support to facilitate adoption. Ultimately, this research highlights the crucial managerial role of digital leadership in linking technological innovation and sustainability, while acknowledging the exploratory nature and limited generalizability inherent in a single-case study.

1 Introduction

In recent years, societies have faced unprecedented environmental, economic, and social challenges, the transition to sustainable development is emerging as a major strategic direction for rethinking growth and governance models [1, 2]. It aims to strike a balance between economic performance, natural resource conservation, and social equity, positioning green technologies as essential levers capable of combining productive efficiency and environmental responsibility [3, 4].

The integration of these technologies into value chains helps reduce the ecological footprint and promote more efficient use of inputs, particularly in environmentally intensive sectors such as agriculture [5, 6]. At the same time, the digitization of economic activities is thoroughly redefining modes of production, management, and governance by introducing smart and interconnected solutions that optimize resource management, improve process traceability, and support strategic decision-making [7, 8], thereby enhancing the

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sustainability of systems while strengthening organizational competitiveness when geared towards ecological objectives [9].

However, the success of both ecological and digital transitions does not depend solely on technological availability, but also on strong organizational and managerial capabilities, in which digital leadership plays a central role by ensuring consistency between the sustainable vision and innovation, promoting the adoption of green technologies, and helping to overcome cultural resistance to change [5, 8, 10].

In line with this dynamic, this research examines the contribution of green technologies to sustainability through the lens of digital leadership. Based on a qualitative approach, it draws on a case study conducted in Tunisia in the agricultural sector. By analyzing the perceptions and practices of an innovative business leader, this study aims to highlight the interactions between technological innovation, sustainability, and leadership, while emphasizing the conditions for a successful transition to a sustainable business model.

2 Literature review

2.1 Sustainability

Sustainability has become a central concept in both academic and managerial discourse [11], seeking to reconcile economic progress, social equity, and environmental preservation [12, 13]. According to reference [14], it represents the ability of a system to maintain its essential functions over time without compromising the needs of future generations. This concept is based on three interdependent dimensions: economic, social, and environmental sustainability.

The economic dimension aims to ensure financial viability and long-term value creation [15, 16]. Social sustainability, according to references [17, 18], emphasizes equity, cohesion, and quality of life for individuals, particularly through poverty reduction and community participation. Finally, environmental sustainability, considered the foundation of the other two pillars, refers to the prudent management of natural resources and the fight against growing ecological pressures [19, 20].

In the context of SMEs, sustainability extends beyond an ethical concern to become a strategic lever that promotes competitiveness and long-term resilience [21, 22]. Despite their limited resources, these companies have organizational agility and social proximity that enable them to integrate sustainable practices more effectively [23]. As reference [24] highlights, the environmental competitiveness of an SME reflects its ability to maintain and develop its market share through eco-responsible strategies. In this sense, sustainability becomes a driver of innovation and an indicator of overall performance.

2.2 Green technologies, sustainability, and the role of digital leadership

Green technologies are an essential pillar of sustainable development, combining technological innovation and ecological responsibility [25, 26]. They encompass all products, processes, and systems that reduce greenhouse gas emissions, preserve natural resources, and promote the circular economy [19, 27, 28]. According to reference [1], these technologies represent a new trend in which innovation and sustainability converge towards a “green economy,” driving more responsible growth.

Several researchers, including references [29, 30], demonstrate that the integration of green technologies simultaneously improves the economic, social, and environmental performance of companies by reducing energy consumption, increasing productivity, and strengthening

social equity through the creation of sustainable jobs. In SMEs, their adoption often results in competitive differentiation and improved corporate image [31, 32].

Nevertheless, the effectiveness of green technologies largely depends on managerial vision and leadership capabilities within organizations [33]. In this regard, digital leadership plays a decisive role in the strategic alignment between technological innovation and sustainability objectives [5, 8, 10]. In the case of SMEs, this stance translates into the leader's ability to mobilize smart technologies, such as artificial intelligence, the Internet of Things (IoT), and connected sensors, to optimize resource management and enhance productivity while minimizing environmental impact [1, 34].

Digital leadership thus acts as a catalyst for sustainability: it promotes the adoption of green technologies, stimulates eco-responsible innovation, and anchors sustainability at the heart of organizational strategies [35]. As reference [36] points out, the success of sustainable digital transformation depends above all on the leader's ability to articulate a technological vision and a strong environmental commitment. In short, green technologies and digital leadership are coming together to transform sustainability from an abstract ideal into a concrete and measurable process, where economic, social, and environmental performance converge toward globally sustainable development [1, 33, 37, 38].

3 Methodology

Given the emerging nature of research on the impact of green technologies and digital leadership on the sustainability of Tunisian SMEs, this study adopts an exploratory qualitative approach, such an approach is particularly appropriate for investigating complex and under-explored phenomena within their real-life contexts.

In order to obtain contextualized empirical results, the research is based on a single case study, allowing the phenomenon to be observed in a real-world setting and the theoretical contributions of the literature to be articulated with concrete organizational practices [39, 40]. The chosen company, SmartFarm TN, is a relevant case study due to its dual technological and sustainable focus. It positions itself as a green Tunisian SME specializing in the development of smart irrigation solutions integrating the Internet of Things (IoT) and artificial intelligence (AI) to optimize water management and improve agricultural performance.

The choice of SME studied meets specific criteria directly related to the objectives of this research, in particular its commitment to sustainable practices focused on water resource conservation, its integration of digital and green technologies into its innovation processes, and the availability of its CEO, who is recognized for his strategic vision and digital leadership committed to sustainability.

Data were collected through a semi-structured interview with the CEO and co-founder of SmartFarm TN, Bechir BenBrika, who has over 17 years of experience in digital development and entrepreneurship. The interview, which lasted approximately 60 minutes, was conducted via Zoom, recorded with the participant's consent, and then transcribed in full to facilitate analysis. The interview guide was developed based on existing literature and structured around three themes: sustainability, green technologies, and digital leadership.

Data analysis was based on a thematic approach inspired by the work of reference [41], which allowed recurring patterns to be identified from the participants' discourse. An initial exploratory reading identified key ideas, which were then grouped and classified according to the main themes from the interview guide. This method, widely used in qualitative research, promotes rigorous and objective interpretation of data by linking empirical observations to conceptual frameworks on technological sustainability and the role of digital leadership.

4 Results

4.1 Commitment to sustainability

Given that sustainable development is increasingly recognized as a strategic imperative for businesses, it requires striking a balance between economic performance, environmental protection, and social equity. As noted in reference [42] corporate sustainability is based on a systemic relationship with the natural environment and requires an integrated and cross-functional approach. At SmartFarm TN, this approach translates into a vision that places sustainability at the heart of its organizational strategy.

According to Bechir BenBrika, co-founder and CEO, sustainability is a prerequisite for the resilience of the Tunisian agricultural sector. Nowhere is this more evident than among small and medium-sized producers, who account for nearly 75% of national farms. These actors face severe water shortages and economic vulnerability. They therefore need simple, affordable technological solutions that are adapted to local conditions. SmartFarm TN was created to meet these needs, in a context where 10% of cultivated land consumes 80% of available water resources.

The company has developed a smart irrigation solution supported by connected sensors and a digital platform. As well as this technological system, there are training and awareness initiatives for farmers. All these actions together show a multidimensional approach to sustainability. On the economic side, the solution cuts production costs and boosts yields. On the environmental side, it helps conserve water and soil through better irrigation practices. On the social side, it supports small producers and encourages more inclusive and responsible farming models.

SmartFarm TN 's strategy also incorporates ethical and human considerations. The CEO insists that respect for the environment and people is a fundamental value of the organization. This approach positions sustainability not only as a compliance requirement, but also as a source of differentiation and competitive advantage.

These contributions notwithstanding, several constraints remain. The technical complexity of the system and its acquisition cost limit its adoption by small farmers. In addition, resistance to technological change is a major cultural barrier. In response, SmartFarm TN prioritizes capacity building and ongoing support, with the aim of promoting long-term behavioral change among producers.

4.2 Green technologies

An analysis of the SmartFarm TN CEO's speech highlights a comprehensive and inclusive approach to green technologies. For Bechir BenBrika, a technology is considered green when it minimizes negative impacts on the environment (soil, water, air) while supporting the performance of agricultural systems.

In practice, SmartFarm TN integrates IoT sensors capable of measuring soil moisture, temperature, and salinity in real time. This data is transmitted to a digital platform that uses artificial intelligence to automatically control irrigation. This approach achieves water savings of up to 20% while improving agricultural yields. Beyond the technological aspect, the company also adopts responsible practices such as using recycled materials for its communication media, illustrating sustainability integrated at all levels of its business.

Despite this sustainable approach, economic and administrative constraints remain. The initial cost of the solution, estimated at around 2000 dinars, remains high for small farmers, while cumbersome subsidy procedures hinder access. Aware of these challenges, SmartFarm TN is committed to continuous improvement by developing more advanced versions of its solution, incorporating new features (fertilization management, disease prevention, crop

maturity monitoring). This dynamic of innovation is part of a participatory co-construction process with end users, who are considered true partners in the product's evolution.

4.3 Digital leadership

The SmartFarm TN experience fully illustrates the strategic role of digital leadership in the success of an ecological transition. The profile of Bechir BenBrika, an IT development engineer and experienced entrepreneur, embodies that of a proactive and visionary leader capable of combining technological innovation with sustainable values. This type of leadership is based on a constant curiosity for innovation, an ability to adapt quickly, and personal resilience in the face of uncertainty.

According to BenBrika, technology is not simply a support tool, but a central pillar of SmartFarm TN's strategy. It is integrated into all activities: internal management, customer relations, training, communication, and product development. The CEO also emphasizes the importance of organizational consistency, believing that the company must reflect the technological principles it promotes in its own practices: *"If we are going to offer a technology, and we ourselves use something that is not technological, it is a contradiction."* BenBrika's digital leadership is based on interdisciplinary collaboration, combining the company's internal skills with external partnerships.

Finally, the CEO expresses a desire to formalize the company's commitment through regulatory frameworks and future certifications. This strategic direction reflects a commitment to continuous improvement and institutional legitimacy.

5 Discussion and contributions

The objective of this research was to examine how green technologies and digital leadership can contribute to sustainability within SMEs. The results from the SmartFarm TN case study and the literature show that green technologies represent both a strategic lever and a source of challenges in the implementation of sustainable practices.

The analysis reveals that sustainability is not limited to an ethical ideal, but is a multidimensional dynamic, integrating economic, environmental, and social dimensions [2, 42]. In theory, it is based on structured frameworks such as Corporate Social Responsibility (CSR) and the Sustainable Development Goals (SDGs) [1, 37]. In practice, SmartFarm TN adopts a more operational and contextual approach, focused on the resilience of small producers and the optimization of water resources. This pragmatic interpretation illustrates the ability of SMEs to translate sustainability principles into concrete actions rooted in their local reality.

Green technologies are perceived in the literature as innovations designed to reduce environmental impact and improve energy efficiency [33, 43, 44]. The case study confirms these contributions, while highlighting the importance of simplicity of use, local adaptation, and accessibility for smallholders. SmartFarm TN thus illustrates a form of frugal technology that is accessible and co-constructed with its users, contributing to an inclusive green transition.

Economically, the research echoes the work of references [2, 22], showing that green technologies can improve productivity and reduce production costs, strengthening the financial resilience of SMEs. From a social perspective, the training and awareness initiatives carried out by SmartFarm TN reflect the human dimension of sustainability, confirming the observations of references [1, 42] on the role of human capital and social responsibility.

However, several obstacles remain: high initial costs, technical complexity, and cultural resistance to change, which is often underestimated in the literature [45]. The study shows

that the success of a green innovation depends not only on technology, but also on education and user support.

Beyond technology, digital leadership is emerging as a key factor in linking innovation and sustainability. The work of references [46-48] emphasize that this leadership is based on proactivity, technological curiosity, and the ability to anticipate change. Mr. Bechir BenBrika's profile perfectly illustrates these qualities: his visionary approach, his alignment of environmental values with technological choices, and his willingness to involve stakeholders reflect leadership geared toward sustainable innovation.

In brief, the discussion highlights a strong consistency between theoretical models of sustainability and practices observed in the field, while emphasizing the need for local contextualization of approaches. The case of SmartFarm TN demonstrates that sustainability cannot be separated from organizational culture or the strategic role of leaders in driving change.

6 Theoretical and managerial contributions

Theoretically, this study enriches the literature on sustainability and green technologies by confirming, in the context of Tunisian SMEs, the work of references [1, 2, 42] on the multidimensional nature of sustainability. It provides original insights by showing how sustainability is interpreted and implemented pragmatically by actors in the field.

First, it confirms the contributions of references [33, 43] that green technologies enhance environmental and economic performance, provided they are accompanied by strong organizational and managerial commitment. Second, this research highlights the importance of technological accessibility as a condition for success, echoing the findings of references [22, 45] on barriers to adoption related to cost and complexity. The case study illustrates a logic of adapted and frugal technology, co-constructed with end users, thus making an original empirical contribution to the literature. Third, the study deepens our understanding of digital leadership in the sustainable transition process. The findings confirm the analyses of references [46-48] by showing that this leadership is based on proactivity, adaptability, and the ability to align technological decisions with environmental values.

From a management perspective, the results offer several lessons. On the one hand, they show that the success of the green transition does not depend solely on technological sophistication, but also on the ability to simplify, adapt, and popularize tools to facilitate their adoption. On the other hand, they highlight the essential role of leaders as catalysts for change: their commitment, vision, and proximity to stakeholders promote buy-in and the sustainability of sustainable practices.

Finally, this study suggests implications for public decision-makers. In order to support the dissemination of green technologies, it is necessary to simplify procedures for accessing financial aid, strengthen digital leadership training programs, and promote support policies adapted to the local realities of the entrepreneurial fabric.

7 Conclusions, limitations and avenues of research

This research examined how green technologies, supported by committed digital leadership, promote sustainability in agricultural SMEs. The SmartFarm TN case study shows that sustainability, often defined as the balance between economic, environmental, and social dimensions [4, 49], is expressed in the field by a priority given to the economic viability and resilience of small producers. The results confirm the contributions of references [5, 9] regarding cost reduction and sustainable water management, while highlighting the central role of digital leadership, characterized by proactivity and adaptability [8, 10]. However,

several obstacles remain, such as access costs, technical complexity, and cultural resistance to change [3, 7]. These findings call for enhanced training, simplified tools, and user support. As in any exploratory qualitative study, this research has certain limitations that are worth highlighting. First, it is based on a single case study, that of SmartFarm TN, which limits the generalizability of the results to other sectoral or geographical contexts. Second, data collection was based primarily on a single interview with the founder and CEO, introducing a degree of subjectivity linked to his managerial perception. The absence of the perspectives of other stakeholders (farmers, employees, or institutional partners) limits the triangulation of sources. Furthermore, although a qualitative approach is well suited to exploring complex phenomena, it does not allow for a precise quantitative measurement of the impact of green technologies on each of the pillars of sustainability. For future work, a mixed or comparative approach could enrich these results by integrating quantitative data and multiple perspectives.

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