3ème Conférence Internationale sur les Sciences Appliquées et l'Innovation (CISAI-2025)
Proceedings Book Series –PBS- Vol 25, pp.22-27

From Digital Gaps to Eco-friendly Innovations: Diagnosis of Challenges Faced by Agri-food Cooperatives of Central Rif in Morocco

Khaoula Alami[#1], Mouad Chentouf[*2], Hasnaâ Harrak[&3]

[#]*Research Unit Resilient Agricultural Systems Development of Al Hoceima, Regional Centre for Agricultural Research of Tangier, National Institute for Agricultural Research (INRA), Avenue Ennasr, PO Box 514, Rabat, Morocco*

[1]khaoula.alami@inra.ma

[*]*Regional Centre for Agricultural Research of Tangier, National Institute for Agricultural Research (INRA), Avenue Ennasr, PO Box 514, Rabat, Morocco*

[2]mouad.chentouf@inra.ma

[&]*Laboratory of Agri-Food Technology and Quality, Regional Centre for Agricultural Research of Marrakesh, National Institute for Agricultural Research (INRA), Avenue Ennasr, PO Box 514, Rabat, Morocco*

[3]hasnaa.harrak@inra.ma

Abstract— **Sustainable agri-food systems rely increasingly on digital transformation and eco-friendly biotechnological innovations to enhance productivity, market reach and valorization of agricultural by-products. In this context, agri-food cooperatives play a vital role in supporting social stability, improving economic growth, and preserving environment. However, these cooperatives face persistent challenges related to digital gaps and sustainable practices. This study aims to examine, through a survey, the hurdles encountered by agri-food cooperatives in Central Rif, namely Al Hoceima province (Northern Morocco), in order to offer innovative green solutions and key actions for sustainable digital growth. Cross-sectional design is employed to conduct a quantitative investigation. The data are collected from a representative sample of 50 agri-food cooperatives operating in the Central Rif, selected through a stratified systematic sampling method to ensure diversity in terms of sector, size, geographical location and level of market integration. Surveyed cooperatives have agreed that limited internet connectivity, low digital literacy, inadequate infrastructure, and affordability issues impede their progress. In fact, findings show that digital marketing remains underutilized. In addition, one of the major challenges detected is lack of access to marketing tools associated with the narrow perception among cooperatives regarding the potential benefits of digitalization, such as traceability, efficiency, and market access. Similarly, this study identified a limited number of cooperatives —precisely 12%— that have adopted digitalization and experienced substantial benefits. Indeed, digital tools enable them to stay informed about emerging trends, communicate with customers via social media and chatbots, meet consumer needs, and participate in relevant events. Furthermore, the survey underscores difficulties in identifying viable methods to valorize local resources and upcycle agro-waste, thereby missing opportunities to strengthen economic resilience. Likewise, the study emphasizes how agrotourism can be used in conjunction with digital transformation and green strategies to promote local products, upgrade agri-food cooperatives, enhance their visibility and market outreach as well as boost community involvement. Green practices are working as catalysts in maintaining a sustainable development. This study also highlights the critical need for tailored capacity-building programs focused on digital literacy and eco-friendly innovations to bridge existing gaps. The establishment of partnerships between cooperatives, researchers, digital transformation consultants, artificial intelligence specialists, and policymakers is imperative. Implementing such measures could empower cooperatives to foster their competitiveness while contributing to sustainable digital food systems.**

Keywords— **Northern Morocco, survey, digital gap, digitalization, eco-friendly innovation, sustainable practices, upcycling, agri-food cooperatives.**

ISSN: 2961-6611

I. INTRODUCTION

Global food systems face enormous challenges, including climate change, malnutrition, biodiversity losses, digital gaps, and food waste. These obstacles compromise the livelihoods of farmers, small producers, agri-food cooperatives, and consumers. Thus, these challenges are driving the global food system towards more sustainable food production and food innovation [1]–[5]. Alternatively, there have been many technological advances in food systems such as pervasive digitalization, biotechnological methods. Sustainable practices including intelligent waste management, digitalization, recycling, upcycling, and renewable energy are supporting circular development. Many countries now consider digital as a key component of their sustainable development objectives. Morocco is among these countries, actively integrating digital initiatives into its development framework. Through the Digital Morocco 2030 strategy, the country focuses on boosting the digital economy by creating a thriving digital ecosystem that will fuel local innovation, generate employment, and increase Morocco's competitiveness in the global market. In this context, agri-food cooperatives play a significant role. They participate in market share and, even more importantly, contribute to rural development [6], [7]. However, these cooperatives present a delay in their digital transformation compared to that of conventional companies [8]. To improve their market access and guarantee sustainability, these organizations must innovate and include digitalization throughout the value chain. Artificial intelligence, big data analytics, mobile technology, and social media platforms are examples of digital innovations [9]. Their benefits are numerous and diverse. For example, digital tools enable agri-food cooperatives to better meet customer expectations by providing customized services and enhancing transparency. Consequently, eco-friendly innovation and green digital technology are intrinsically connected, as green innovation represents a crucial tactic to achieve sustainable development, while green technology refers to the tangible tools and systems that emerge from this innovation and that meet present needs without compromising the ability of future generations to meet their own [10].

While many studies highlight the benefits of digitalization and green innovation, few demonstrate how agri-food cooperatives can embrace these trends, bridge the digital divide, and adopt sustainable practices at a small scale. Hence, this survey aims to diagnose the barriers related to digitalization and market access, identify opportunities for sustainable growth and highlight potential pathways for improving performance.

II. METHODOLOGY

A. Study Area

The survey was carried out in Northern Morocco, with a particular focus on the Central Rif, specifically in Al Hoceima province. The study concentrated on both urban and dominant rural areas of this province. It focused on assessing cooperatives operating in three high-potential sectors within the Central Rif region of Al Hoceima province namely, beekeeping, medicinal and aromatic plants (MAPs), and the valorization of local agricultural resources.

B. Study Design, Sampling Method and Sample Size

This study, taking place during 2025, used a questionnaire based on a cross-sectional design to conduct a quantitative investigation. The data was collected from a representative sample of agri-food cooperatives operating in Al Hoceima province, selected through a stratified systematic sampling method to ensure diversity in terms of sector, size, geographical location and level of market integration.

To ensure statistical representativity, the required sample size was calculated based on Cochran's formula, adjusted for a finite population. The Central Rif region hosts around 100 registered cooperatives across diverse sectors. This study targets 55 cooperatives engaged in beekeeping, MAPs, and agricultural resource valorization, as these align closely with the research objectives. Using a 95% confidence level ($z = 1.96$), an estimated population proportion $p = 0.5$ (maximizing sample size under uncertainty), and a margin of error of 5%, the minimum representative sample size was calculated to be 49 cooperatives. A total of 50 cooperatives were surveyed using this stratified approach, providing broad coverage across all defined strata.

C. Data Collection: Survey Instrument

The questionnaire was developed based on the key themes relevant to the diagnostic objectives of the study, ensuring a structured approach to gathering comprehensive data from agri-food cooperatives. Each section was carefully designed to address specific aspects of cooperative operations, with a focus on identifying challenges, exploring opportunities, and assessing the level of integration of valorization, upcycling practices

ISSN: 2961-6611

and digital tools. On the last page of paper questionnaire, there was an explanatory opening paragraph on the purpose of the study, assuring the confidentiality of the information collected.

D. Data Analysis

The objective of this data analysis is to interpret the survey results effectively using graphical and statistical methods. Excel was utilized as the primary tool for data visualization and analysis, leveraging its robust functions to produce informative graphs and charts. Quantitative data were analysed using descriptive statistics, while thematic analysis was applied to qualitative responses.

III. Results and Discussion

The survey results reveal that most cooperatives primarily rely on direct selling and traditional markets to distribute their products, indicating limited diversification in their marketing channels (Fig. 1).

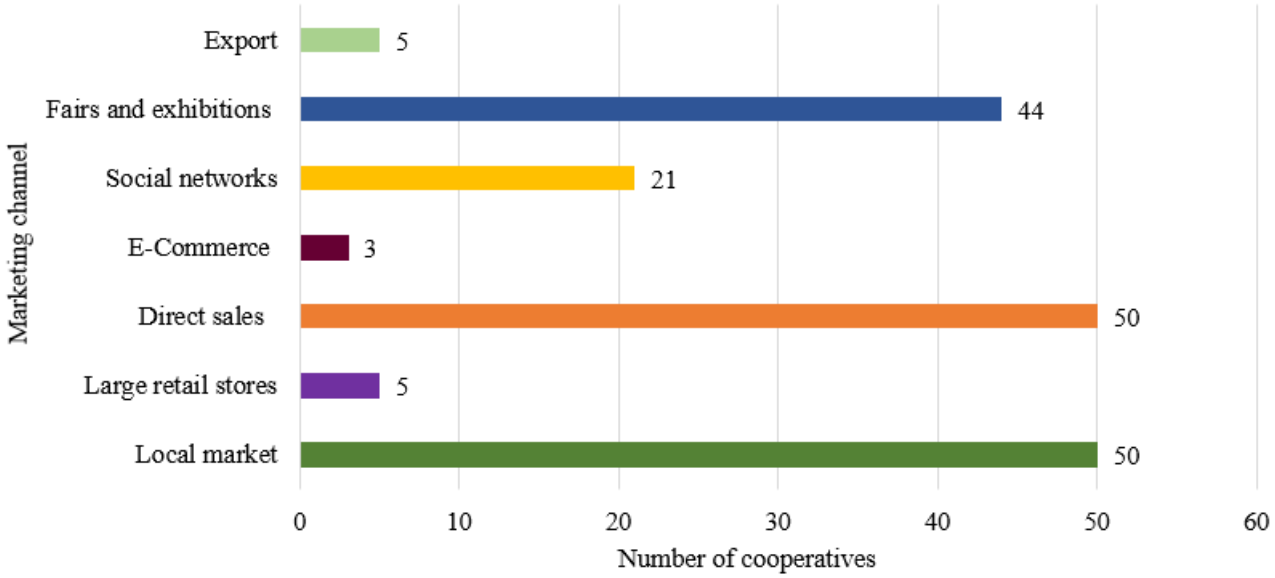

Fig. 1 Cooperative engagement across various marketing channels

Concerning digitalization, the findings highlight a significant disparity between the awareness and effective adoption of digital tools among the surveyed cooperatives. While 50% of the cooperatives reported being aware of digital technologies such as social media platforms and e-commerce tools, only 12% actively integrate them into their operations. This low adoption rate demonstrates a critical gap between knowledge and practice, often attributed to the lack of targeted training and limited digital literacy within these organizations. Additionally, 38% of cooperatives remain completely unaware and unfamiliar with digital tools, underscoring the digital divide that persists in rural and marginalized areas of Al Hoceima province (Fig. 2).

ISSN: 2961-6611

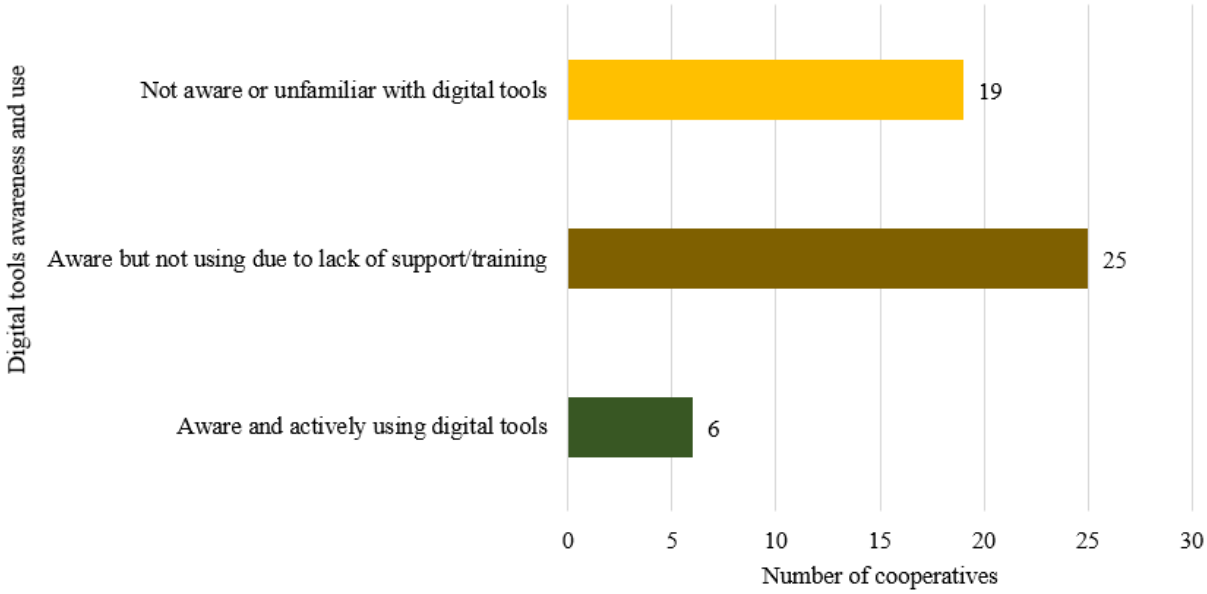

Fig. 2 Awareness and use of digital tools among cooperatives

Regardless of their primary area of activity, most cooperatives demonstrated limited awareness of digital tools and lacked the necessary knowledge to integrate such technologies into their operational and commercial practices.

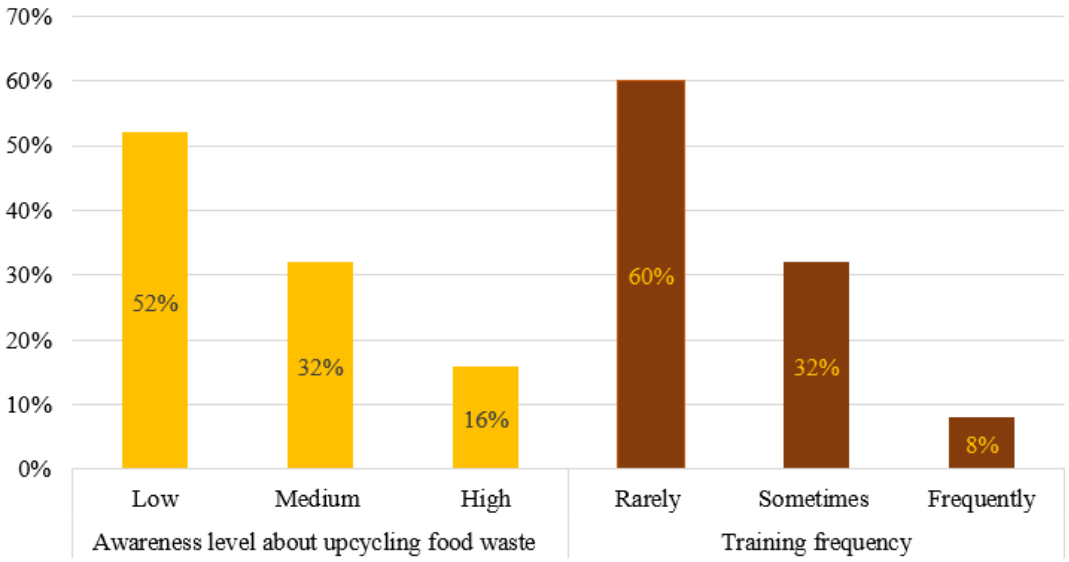

Fig. 3 Impact of training frequency on awareness levels about food waste upcycling

Among the cooperatives surveyed, 30 out of 50 (60%) affirmed the absence of targeted training programs that would enable them to implement sustainable practices. Regarding sustainability practices within the value chain, only 16% of cooperatives that possess high level of awareness about upcycling and have adopted the reuse of food by-residues as scrub products, demonstrating limited but promising engagement in value addition through by-product utilization (Fig. 3). This widespread lack of tailored capacity-building programs significantly hampers the ability of cooperatives to integrate eco-friendly innovations into their operations. To enable cooperatives to support digitalization, and adopt sustainable value chain methods, it is imperative that these gaps be filled. Several solutions can be proposed such as improving internet connectivity in rural and underserved areas. However, infrastructure alone is insufficient without human capacity. Indeed, tailored

ISSN: 2961-6611

training programs focused on digital literacy, data management, green practices and eco-friendly technologies are crucial to ensure effective adoption.

IV. CONCLUSIONS

The importance of digital literacy in ensuring successful sustainable transition cannot be emphasized enough. Context-specific training, tailored support programs, eco-friendly initiatives such as agrotourism, and practical affordable methods play an indispensable role in bridging the gaps related to digitalization, boosting the awareness concerning green practices, enhancing the cooperatives' performance and market integration. Accordingly, strong collaboration among stakeholders, including public institutions, researchers, consultants, and cooperatives in parallel with establishing digital support hubs is fundamental to guarantee access to effective support, knowledge-sharing, and scalable solutions.

ACKNOWLEDGMENT

The authors gratefully acknowledge the support of the National Office of Agricultural Council (ONCA) and the surveyed cooperatives to carry out this study in Moroccan Central Rif.

REFERENCES

[1] S. Abbate, P. Centobelli, and R. Cerchione, "The digital and sustainable transition of the agri-food sector", *Technol. Forecast. Soc. Change*, vol. 187, p. 122222, 2023.

[2] J. Aschemann-Witzel, M. D. Mulders, and S. L. T. Mouritzen, "Outside-in and bottom-up: using sustainability transitions to understand the development phases of mainstreaming plant-based in the food sector in a meat and dairy focused economy", *Technol. Forecast. Soc. Change*, vol. 197, p. 122906, 2023.

[3] F. Cassia and F. Magno, "The value of self-determination theory in marketing studies: insights from the application of PLS-SEM and NCA to anti-food waste apps", *J. Bus. Res.*, vol. 172, p. 114454, 2024.

[4] F. Dal Mas, M. Massaro, V. Ndou, and E. Raguseo, "Blockchain technologies for sustainability in the agrifood sector: a literature review of academic research and business perspectives", *Technol. Forecast. Soc. Change*, vol. 187, p. 122155, 2023.

[5] A. Piancharoenwong and Y. F. Badir, "IoT smart farming adoption intention under climate change: the gain and loss perspective," *Technol. Forecast. Soc. Change*, vol. 200, p. 123192, 2024.

[6] R. Ajates, "An integrated conceptual framework for the study of agricultural cooperatives," *J. Rural Stud*., vol. 78, pp. 467–479, 2020.

[7] COGECA. (2020). The European Agri-Food Cooperatives Monitor 2019. [Online]. Available: http://www.agro-alimentarias.coop/ficheros/doc/06098.pdf

[8] E. Cristobal-Fransi, Y. Montegut-Salla, B. Ferrer-Rosell, and N. Daries, "Rural cooperatives in the digital age: an analysis of the Internet presence and degree of maturity of agri-food cooperatives' e-commerce," *J. Rural Stud*., vol. 74, pp. 55–66, 2020.

[9] G. Vial, "Understanding digital transformation: A review and a research agenda," *J. Strateg. Inf. Syst*., vol. 28, no. 2, pp. 118–144, 2019.

[10] M. T. Islam, "Newly developed green technology innovations in business: paving the way toward sustainability," *Technol. Sustain*., vol. 2, no. 3, pp. 295–319, 2023.

ISSN: 2961-6611