

SMALL AND MEDIUM DAIRY FARMERS: EXPECTATIONS AND NEEDS FOR ICT ON THE FARM

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Abstract. *Information and communication technologies (ICT) are shaping sectors worldwide, including agriculture. This research investigates small and medium dairy farmers (SMDFs)' expectations and requirements for ICT deployment on their farms, by assessing available literature and prospective research topics to give insight on the possibilities and problems related with ICT adoption in this sector. ICT has the potential to impact the dairy industry by enabling SMDFs to improve production, profitability, and animal welfare. Addressing SMDFs' expectations and needs, including cost, usability, connectivity, and training, is vital for ensuring that ICT becomes a positive change driver in the small and medium dairy farm sector. Our research aimed to systematically review existing literature on the expectations and needs of SMDFs regarding ICT deployment on their farms.*

Keywords: dairy farms; TIC; digital transformation; productivity; animal welfare.

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1. Introduction

The dairy industry is undergoing changes that necessitate farmers to meet higher standards for food safety, biosecurity, and animal welfare [4]. To remain competitive, small and medium dairy farmers SMDFs need to optimize efficiency, improve animal welfare, and enhance decision-making. The rise of information and communication technologies (ICT) is transforming industries on a global scale and the dairy industry is no exception [11]. In the agricultural sector, Information and communication technologies (ICT) are increasingly being recognized for their potential to enhance productivity, efficiency, and animal welfare on farms. Small and medium dairy farmers (SMDFs), who constitute a significant portion of the dairy industry worldwide, stand to benefit considerably from ICT adoption [35].

For small and medium dairy farmers (SMDFs), ICT adoption can be a game-changer, offering tools for better herd management, precise feeding practices, and improved health monitoring. However, to ensure that ICT acts as a positive force for change within the small and medium dairy farm sector, it is crucial to address

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the specific expectations and needs of SMDFs. These considerations include cost, user-friendliness, reliable internet connectivity, and access to adequate training [24, 29].

The present study focuses specifically on small and medium dairy farmers (SMDFs) and their expectations and needs for ICT on their farms. SMDFs constitute a significant portion of the dairy industry globally and play a crucial role in ensuring a sustainable and secure food supply. However, they often face challenges related to resource limitations, labor shortages, and volatile market conditions. ICT adoption offers promising opportunities for SMDFs to overcome these challenges and improve their overall farm operations.

Our research aimed to systematically review existing literature on the expectations and needs of SMDFs regarding ICT deployment on their farms. By analyzing current research, the study seeks to identify the potential benefits of ICT adoption for SMDFs, including improving production efficiency, profitability, and animal welfare, explore the challenges faced by SMDFs in implementing ICT solutions, such as cost concerns, user-friendliness, internet connectivity limitations, and lack of technical expertise. Additionally, we aimed to formulate future research directions that address the specific needs and expectations of SMDFs for successful ICT integration within their operations.

2. Materials and methods

This systematic review followed a structured approach to identify, select, and analyze relevant literature. Databases such as PubMed, Scopus, and Google Scholar were searched using keywords like "dairy farms," "ICT," "digital transformation," "productivity," and "animal welfare." The inclusion criteria focused on studies published in the last ten years, written in English, and specifically addressing small and medium dairy farms. The retrieved literature was then critically evaluated based on pre-defined inclusion and exclusion criteria. This ensured the selection of relevant and high-quality studies that address the research question. The extracted data was thematically analyzed to identify key themes related to SMDFs' expectations and needs for ICT on their farms.

By conducting thorough research and engaging with small and medium dairy farmers, policymakers and technology developers can gain valuable insights into their desired features, functionalities, and support systems. This understanding can then contribute to the design and implementation of ICT solutions that address the unique challenges faced by small and medium dairy farmers, ultimately helping them improve productivity, efficiency, and profitability. Moreover, it can also facilitate their access to important resources such as market information, veterinary services, and financial support [6, 25, 10].

By leveraging ICT, small and medium dairy farmers can streamline their operations, make data-driven decisions, and optimize resource utilization. This can lead to improved milk quality, increased yields, and enhanced overall farm management [23, 21, 38, 20, 37].

3. Results and Discussions

3.1. Expectations and Needs of SMDFs

Factors influencing the adoption of technologies by small-scale dairy farmers include perceived usefulness, productivity benefits, farmer skills, and farm characteristics [24]. Moreover, the use of ICTs in small-scale dairy production systems has been on the rise, prompting questions about their importance and role in farm activities [12].

Studies have shown that ICT tools play a significant role in providing technical, market, and financial information to dairy farmers, impacting their productivity and access to resources [29]. The perception and quality of ICT-based agricultural input information influence the use of ICTs by farmers in developing countries, highlighting the importance of farmers' attitudes towards technology [36, 16, 9, 5]. Furthermore, the COVID-19 pandemic has underscored the need for dairy enterprises to enhance their resilience through measures like feed storage and milk processing [18, 7, 15, 31, 8].

Our research revealed that SMDFs have high expectations for ICT in terms of improving farm efficiency, animal welfare, and profitability. However, these expectations are tempered by concerns about affordability, ease of use, and the availability of reliable support and training (Figure 1).



Figure 1. The main expectations of farmers regarding ICT identified in the reviewed literature

To facilitate the effective adoption of ICT, several key needs must be addressed:

Cost and Usability

Cost is a significant barrier for SMDFs when considering ICT adoption. Farmers expect affordable solutions that provide a clear return on investment. Usability is equally important; ICT tools must be user-friendly and require minimal training to ensure widespread adoption. Studies indicate that complex interfaces and high costs deter farmers from investing in new technologies.

Connectivity

Reliable internet connectivity is a prerequisite for effective ICT deployment. Many rural areas, where small and medium dairy farms are typically located, suffer from poor internet infrastructure. This lack of connectivity hampers the use of cloud-based applications and real-time data analytics, limiting the benefits of ICT.

Training and Support

Training and ongoing support are critical for successful ICT implementation. SMDFs require comprehensive training programs to understand and effectively use new technologies. Continuous technical support ensures that any issues can be promptly addressed, minimizing disruptions to farm operations.

3.2. Benefits of ICT Adoption

In the context of sustainability, reducing food waste in dairy supply chains can be achieved through efficient logistics operations supported by modern ICT applications [27]. Consumer pressure for sustainable dairy production has led to commitments within the industry to reduce environmental footprints, emphasizing the importance of nutrient cycling in intensive dairy regions [22]. Intangible capital, particularly in ICT-intensive industries, has been linked to higher productivity growth, indicating the potential benefits of ICT adoption in various sectors.

The use of ICT-based extension services has shown promise in improving dairy production and household welfare, demonstrating the positive impact of technology on farmers' outputs and incomes [2, 30]. Leveraging ICT infrastructure in dairy cooperatives can bridge information gaps and drive institutional innovation within the industry [17, 26]. Additionally, the adoption of ICTs among dairy farmers is influenced by factors such as age, education, and landholdings, highlighting the need to consider socio-economic characteristics in technology adoption [13, 28, 19, 14, 1, 32, 3].

Improved Productivity

ICT can significantly enhance productivity through automation and data-driven decision-making. Automated milking systems, for example, reduce labor costs and increase milk yield. Precision farming technologies enable farmers to monitor animal health and nutrition closely, leading to better overall herd management. Farm management software can streamline daily tasks such as record-keeping, inventory control, and financial tracking. Additionally, ICT platforms can connect farmers with suppliers, distributors, and consumers, facilitating better market access and potentially improving profitability [34].

Enhanced Animal Welfare

Technologies such as wearable sensors and smart feeding systems contribute to improved animal welfare by providing continuous monitoring and personalized care. Early detection of health issues through data analytics ensures timely interventions, reducing the incidence of diseases and improving the quality of life for dairy cattle [19].

Increased Profitability

ICT-enabled technologies like satellite imagery and soil moisture sensors can provide insights into field conditions, enabling SMDFs to apply resources like fertilizer and water more precisely. This can lead to increased yields, reduced environmental impact, and cost savings. By optimizing resource use and reducing wastage, ICT can lead to substantial cost savings and higher profitability. Efficient farm management practices enabled by ICT also open up opportunities for value-added products and services, further enhancing revenue streams [33].

3.3.Challenges in the adoption of TIC on farms

Despite the potential benefits, several challenges hinder the widespread adoption of ICT among SMDFs. The study identified significant barriers to ICT adoption, including financial constraints, technical challenges, and limited access to reliable connectivity [35]. Addressing these barriers is essential for the widespread implementation of ICT in the dairy sector:

Cost: The initial investment and ongoing maintenance costs of ICT tools can be prohibitive for small and medium farmers.

Usability: ICT solutions must be user-friendly and accessible to farmers who may not have advanced technical skills.

Connectivity: Reliable internet access is a prerequisite for many ICT applications, which can be problematic in rural areas.

Training and Support: Adequate training and continuous support are essential for farmers to effectively use ICT tools.



Fig. 2. Main challenges that hinder the adoption of ICT in farms

3.4. Future Research Directions

While existing research provides valuable insights, there is a need for further investigation into the specific expectations and needs of SMDFs regarding ICT on their farms. Future research should focus on bridging the gap between the potential and reality of ICT adoption in SMDFs.

Addressing Cost and Accessibility

Future research should focus on developing cost-effective ICT solutions tailored for SMDFs. Subsidies and financial incentives could also be explored to lower the initial investment barrier. Additionally, improving rural internet infrastructure is crucial for ensuring that SMDFs can fully leverage the benefits of ICT.

Enhancing Usability and User Experience

Research should prioritize the design of intuitive and easy-to-use ICT tools. Involving farmers in the design process can ensure that the solutions meet their practical needs and preferences. User-friendly interfaces and simplified functionalities can drive higher adoption rates among SMDFs.

Comprehensive Training Programs

Developing and implementing robust training programs is essential for empowering farmers to use ICT effectively. Research should explore the most

effective training methodologies and support systems, including the use of demonstration farms and peer learning networks.

Integration and Interoperability

Future research should also focus on the integration and interoperability of various ICT tools and platforms. Seamless data exchange between different systems can provide a holistic view of farm operations, enabling better decision-making and enhancing overall farm management.

Conclusions

(1) By systematically reviewing existing literature, this study will provide valuable insights into the expectations and needs of SMDFs regarding ICT adoption on their farms. Understanding these factors is crucial for developing and implementing effective interventions that can bridge the digital divide in the dairy industry.

(2) By addressing the cost concerns, usability issues, and connectivity limitations faced by SMDFs, ICT has the potential to become a powerful tool for enhancing productivity, profitability, and animal welfare in the small and medium dairy farm sector.

(3) Furthermore, exploring the future research directions outlined in this study will pave the way for the development of innovative ICT solutions that empower SMDFs to thrive in the digital age of agriculture.

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Notations and/or Abbreviations

Small and medium dairy farmers - SMDFs

INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)

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