CHAPTER 2

Digital transformation of small agribusiness through innovative technological solutions in the context of sustainable rural development

Volodymyr Silchenko
Lesia Kononenko
Vira Savchenko
Alla Karnaushenko
Yuliia Hlavatska

Abstract

The study substantiates the need for digital transformation of small agribusiness in Ukraine as a means to implement innovative technological solutions and ensure sustainable rural development. The paper demonstrates that the digital transformation of small agribusiness goes beyond mere technological renewal and becomes systemic, creating preconditions for increased competitiveness, adaptive capacity, and sustainable development, particularly for enterprises operating in frontline and de-occupied territories.

The methodological basis of the study is an interdisciplinary approach that combines economic, social, and technological analysis. The case method, based on the example of cooperation between Remsintez LLC and small agribusiness entities – clients, questionnaire surveys, assessment of digital readiness, digital maturity, and digital potential of small agribusinesses, as well as quantitative and qualitative methods for summarizing and interpreting the results have been used.

The study found that the digital transformation of small agribusinesses has a multi-faceted effect: economic – through cost optimization, increased productivity, and investment attractiveness; social – through the development of digital skills, increased employment, and community sustainability; ecological – through the rationalization of resource use and the introduction of principles of sustainable and precision farming. It has been proven that the effectiveness of digital change increases significantly when service, consulting, and partnership models of interaction are used, providing a synergistic effect for small agribusinesses and resource suppliers.

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The scientific novelty of the study lies in the comprehensive integration of the categories of digital readiness, digital maturity, and digital potential, along with an assessment of the synergistic economic, social, and environmental effects of the digital transformation of small agribusinesses in conditions of increased instability. The practical significance of the results lies in their potential for informing the development of digital strategies and service and consulting models aimed at ensuring sustainable rural development and the restoration of rural areas.

Keywords

Digital transformation, small agribusiness, innovative technological solutions, digital readiness, digital maturity, digital potential, service and consulting model, sustainable development, consulting, synergistic effect.

2.1 Introduction

The modern development of the agricultural sector is taking place amid growing economic, social, and environmental challenges, which necessitate the search for new models to improve the efficiency and sustainability of agricultural production. The depletion of natural resources, climate change, disruptions in logistics chains, and growing market instability significantly complicate the functioning of agribusiness, especially in the small enterprise segment. For Ukraine, these challenges are exacerbated by the consequences of military action, which necessitate restoring agricultural production, preserving food security, and ensuring the viability of rural areas, including those in frontline and de-occupied territories.

Modern agribusiness is influenced by two interrelated megatrends: digital transformation and the imperative of sustainable development. Digital technologies are increasingly penetrating production and management processes, shaping new approaches to planning, monitoring, and resource use. At the same time, the concept of sustainable development involves balancing economic efficiency, social responsibility, and environmental protection. For small agribusinesses, integrating these two vectors is not only a prerequisite for increasing competitiveness but also a means of adapting to complex economic conditions.

Small agribusinesses play a key role in ensuring food security, employment, and the preservation of rural settlements. At the same time, this segment is the most vulnerable to resource constraints, a shortage of skilled workers, low levels of digital literacy, and limited access to innovative technologies. For enterprises operating in high-risk areas, particularly in frontline and de-occupied territories, these problems are exacerbated by infrastructure destruction, market instability, and the need to

restore production capacity. Under such conditions, digital transformation takes on not only innovative but also adaptive and restorative significance.

In contemporary research, digital transformation is increasingly viewed as a practical tool for post-war recovery and regional development, rather than merely an element of technological modernization. In particular, studies emphasize the role of digital platforms, analytical systems, and decision-support models in ensuring the remediation of economic and natural systems under complex post-crisis conditions [1, 2].

The digital transformation of small agribusinesses is a systemic process that combines technological upgrades with organizational and managerial changes, including the introduction of digital accounting and monitoring systems, precision farming technologies, data analytics, the formation of a digital culture among staff, and the reengineering of business processes.

At the same time, the effectiveness of the digital transformation of small agribusinesses depends significantly on their level of digital readiness, digital maturity, and existing digital potential. Given the limited financial, human, and organizational resources, it is often insufficient digital maturity that becomes a limiting factor in the implementation of innovative technological solutions, which necessitates a comprehensive assessment of the state of digital development of small agribusinesses and the search for mechanisms to support it, in particular through service, consulting, and partnership models of interaction aimed at ensuring sustainable rural development.

The aim of the study is to conceptualize and empirically substantiate the digital transformation of small agribusinesses as a mechanism for introducing innovative technologies and ensuring sustainable rural development. Three scientific hypotheses have been formulated to achieve this goal:

– the digital transformation of small agribusinesses provides simultaneous economic, social, and technological effects;

– the digital competencies of personnel and access to digital infrastructure are critical conditions for successful transformation;

– the use of service-consulting and partnership models ensures economic, social, and environmental efficiency.

2.2 Digital maturity of small agribusinesses as the basis for technological renewal

The global transformations of the modern world are primarily driven by two megatrends: the digital revolution and the imperative to achieve the Sustainable Development Goals. In the agricultural sector, this takes on specific characteristics:

digitalization is mainly technological, while sustainable development focuses on supporting rural areas and on environmental and social aspects. At the level of individual agricultural enterprises, these vectors are integrated into strategic planning. The competitiveness of modern agribusiness depends on combining an effective digital strategy with the implementation of sustainable rural development goals.

In agribusiness, ensuring competitiveness in today's environment primarily depends on innovative technological solutions that drive digital transformation [3]. Even though most owners, management representatives, and potential investors in agribusiness entities associate the development of agribusiness entities with the permanent and systematic introduction of digital technologies, research by European scientists indicates an ambiguous perception and attitude towards the introduction of digital technologies in their own small agribusinesses. It is confirmed by the study based on interviews with the most sustainable small agricultural enterprises in Poland, Romania, and Lithuania (20 businesses in each country), using the CRITIC-TOPSIS method to assess attitudes, behavior, and knowledge of the latest digital technologies [4]. Accordingly, the researchers found that the surveyed small agricultural enterprises mostly do not use modern digital technologies. The authors [4] note that owners recognize and appreciate the benefits of using the latest digital technologies. Still, they are unsure whether to implement them in their businesses due to significant obstacles and complications. Agribusiness representatives consider the following to be the main obstacles and complications: low level of digital competence among employees and owners, insufficient information on the cost of implementing and using the latest digital technologies, low motivation due to small-scale production and a preference for traditional, time-tested methods and approaches [4]. In addition, the readiness to implement the latest digital technologies (and, accordingly, the awareness of the need to increase digital maturity) is significantly influenced by the remote location of small agribusiness enterprises, which face challenges with financial, human, material, technical, and other forms of support. The above factors are characteristic of most developing countries [5].

In Ukraine, there are also problems associated with overcoming the negative consequences of full-scale military operations. Accordingly, in the current Ukrainian context, small agribusinesses that not only implement individual elements of digitalization in their economic activities, but also develop and integrate a digital strategy [6] into their social structure, ensuring not only economic efficiency but also the social revitalization of their communities through the creation of new, high-tech jobs.

Ukrainian small agribusinesses are the foundation of the country's food security and a driver of sustainable rural development, ensuring the preservation of the rural settlement network [7]. Accordingly, ensuring the competitiveness of Ukraine's

small agribusinesses through the introduction of innovative digital technologies is of interest to agribusiness owners and employees, as well as to local communities and society as a whole.

An objective prerequisite and factor for digital transformation is an appropriate level of digital maturity [8]. To develop and implement an effective mechanism for the digital transformation of small agribusinesses, it is necessary to conduct a realistic assessment of their current state, which will provide an objective analytical overview, identify hidden problems, and compare their level of development with both best industry practices (*benchmarking*) and strategic plans for the implementation of innovative technologies. Only a sufficient level of digital maturity of a business entity can guarantee economic stability, tax capacity, and effective partnership in the context of total digitalization. The use of digital maturity assessment models enables owners and managers of small agribusinesses to obtain not only static information about the current state but also clear guidelines for further development. Structurally, such models should be based on a system of measurements and detailed criteria that describe the specific practices and actions necessary for a business's evolutionary transition to higher levels of digital maturity.

In scientific literature, the term "maturity" is interpreted as an ideal state (standard) that provides the subject with a clear guideline for long-term development and self-improvement [9]. Accordingly, the maturity model is a fundamental tool for diagnosing the current state of a business entity, allowing its real capabilities to be verified and compared with the desired (target) level of development.

In a digital context, such an assessment takes on a systemic nature, as it is aimed at analyzing not individual technological elements, but the entire set of transformational changes, going beyond a simple audit of the equipment or existing software and focusing on assessing readiness for comprehensive digital transformation in three key areas:

– strategy – the level of integration of digital goals into the overall development strategy of the enterprise;

– technology adoption – the degree of adaptation of innovations by staff and their readiness for daily use;

– business processes – the depth of reengineering of traditional operations (from sowing to marketing) based on digital data and analytics.

To ensure scientific accuracy and practical effectiveness in managing digital transformation processes, it is crucial to distinguish among the concepts of "digital readiness", "digital maturity", and "digital potential". This distinction is of fundamental importance for small agribusinesses, which, in the early stages of digitalization, on the one hand tend to overestimate their own capabilities and, on the other hand, often have significant but hidden potential that remains unrealized.

Digital readiness is an assessment of prospects conducted before the active phase of transformation begins, aimed at determining the availability of the necessary mental, financial, and resource foundation for implementing changes. Digital maturity, on the other hand, is descriptive and reflects the current state of development of digital competencies, infrastructure, and organizational practices, recording the level of digital transformation already implemented [10].

Digital potential, unlike readiness and maturity, characterizes the theoretical limit of digital development achievable through targeted mobilization and optimization of available resources. In the scientific literature, potential is defined as a generalized characteristic of an unrealized capacity or opportunity that includes structured factors capable of being translated into actual action under certain conditions [11]. In the context of the digital transformation of small agribusinesses, this refers to the hidden potential of systematically combining human capital, technologies, and organizational solutions that, under the right managerial and institutional conditions, can deliver disproportionately high growth. Accordingly, if digital readiness reflects the subjective ability and intention to initiate transformational change, and digital maturity demonstrates the level of digital development achieved, then digital potential is the theoretically achievable limit of digital growth achievable by optimizing existing resources [12]. For small agribusinesses, analyzing digital potential is critically important because it enables them to identify "leapfrog" development opportunities in which relatively minor digital initiatives can yield maximum economic and managerial impact.

It should be noted that the relationship between the categories of "digital readiness", "digital maturity", and "digital potential" is not linear (**Fig. 2.1**).

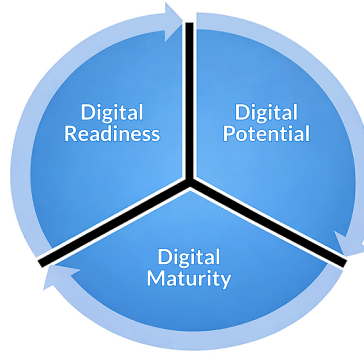

Fig. 2.1 Relationship between the categories of "digital readiness", "digital maturity", and "digital potential" in the context of digital transformation
Source: visualized by the authors of this study

A small agribusiness entity may demonstrate high digital readiness despite a low level of digital maturity; at the same time, it may have a relatively high level of hidden digital potential that can be realized through targeted management decisions. At the same time, the opposite situation is also possible: with a sufficient level of current digital maturity, the digital potential for further development is limited by organizational inertia, personnel constraints, or a lack of investment resources.

The above is consistent with empirical studies on the financial security of agricultural enterprises in Ukraine, which indicate a close relationship among financial capacity, investment activity, and the ability to implement digital solutions [13].

The assessment of these categories is carried out through a measurement system. A measurement is a separate component of the model that describes a key aspect of the enterprise's activities (e.g., personnel's digital literacy or supply chain management). The use of measurement tools enables the assessment of digital transformation at hierarchical levels [10], which in turn enables gradual, step-by-step technological upgrades with minimal risk of financial overload.

Given the applied nature of management decisions in the field of digital transformation, digital maturity takes on particular importance as an integral characteristic of the current state of development of a small agribusiness entity, which can be directly measured, compared, and used as a basis for strategy development. Unlike digital readiness and digital potential, which are preliminary and predictive, respectively, digital maturity is a key operational benchmark for planning and implementing digital transformation.

Despite numerous theoretical models for measuring digital maturity, in practice, business entities' self-assessment processes and the implementation of digital transformation often fail. For small agribusinesses, the key barriers are primarily managers' cognitive biases, the low quality of primary data, and the lack of adaptation of universal methodologies to the specifics of agribusiness. Another common mistake is a fragmented approach, in which the primary focus is on the technological dimension while issues of organizational culture, change management, and staff training are neglected. Under such conditions, the assessment of digital maturity becomes inadequate, leading to strategic miscalculations.

In today's environment, assessing a business entity's digital maturity essentially involves measuring components such as technology, digital culture, operational processes, digital strategy, and management [8, 14]. In the context of small agribusinesses, it is difficult to ensure both the measurement process itself and the implementation of digital transformation. On the one hand, digital transformation enables much more efficient management of business processes, thereby minimizing corruption risks and human error. On the other hand, the conservatism of small

agribusinesses, the slow pace of organizational change, and the reluctance to adopt cost-effective and digital processes create an additional burden on the business.

Based on a survey of representatives of small agribusinesses in the Kirovohrad region, it was found that even with an awareness of the need for digitalization (99%), the majority of respondents (87%) noted the existence of organizational and financial difficulties in the practical implementation of digital changes and the need to develop and support the use of a managerial and economic mechanism. It is possible to optimize this process by using digital platforms [15], which enable the implementation of a model of shared equipment use [16, 17].

Strategic partners in the digital transformation of small agribusinesses can be suppliers of modern agricultural equipment seeking to expand their sales, which, in turn, requires a corresponding level of digital maturity on the part of users. In this context, it is advisable to assess digital transformation readiness primarily by measuring the digital maturity and digital readiness of potential buyers of agricultural machinery – small agribusinesses. Thus, to optimize their activities, suppliers of agricultural machinery must have a thorough understanding of their customers, particularly their digital maturity, digital readiness, and digital potential. At the request of Remsintez LLC, within the framework of the economic contract, a questionnaire was developed, and a customer survey (existing and potential customers) was conducted to assess these parameters. The assessment of the digital maturity of small agribusiness entities was carried out using a comprehensive approach that combines quantitative and qualitative indicators and takes into account their specific operational features. The proposed approach is based on a block structure for the questionnaire, which enables consistent identification of the current level of digitalization, organizational readiness for digital change, and existing digital development potential (**Fig. 2.2**).

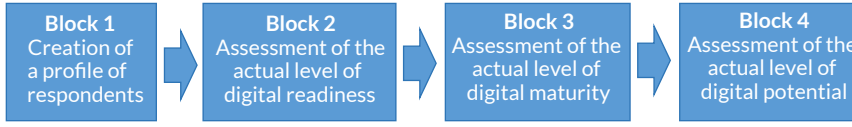

Fig. 2.2 Block structure for assessing the digital transformation of small agribusinesses
Source: visualized by the authors of this study

The first block was aimed at forming a profile of respondents and involved collecting general information about enterprises (size of land holdings, field of activity, region, client status). According to the survey results (984 actual clients – group 1; 812 potential clients – group 2), it was established that 32% of respondents in group 1 belong to small agribusiness entities, while among group 2 potential clients,

small agribusiness entities account for 92% of respondents, which corresponds to the structure of agribusiness entities in the country by size [18]. Accordingly, to expand Remsintez LLC's customer base, it is advisable to focus on small agribusinesses and account for the segment's specificities.

The second block was aimed at determining the business's digital readiness and included assessments of the leadership's position, staffing, personnel's digital competencies, and readiness for training and service support.

The third block covered the assessment of the actual level of digital maturity, in particular the use of digital accounting, navigation, and equipment-monitoring systems, precision farming elements, and data for management decision-making. This block enabled recording the actual state of digital technology implementation without accounting for the declarative intentions of business entities.

The fourth block concerned digital potential and enabled assessment of financial and technological opportunities for further development, interest in implementing "smart" technology, integrated digital solutions, and partnership models for interaction with suppliers.

The survey results indicate a positive environment for the digital transformation of small agribusinesses. Thus, 84% of the surveyed enterprises (from two groups) recognize the need for continuous improvement in digital maturity and have a positive attitude toward digital transformation as a tool to improve business efficiency.

At the same time, the data obtained indicate a specific gap between the awareness of the importance of digital change and the actual level of use of digital technologies, which confirms the expediency of assessing digital maturity in conjunction with digital readiness and digital potential, allowing not only to record the current state, but also to identify areas for targeted influence by suppliers of agricultural machinery and digital services.

Digital maturity was assessed through a questionnaire survey, in which each block contained a set of indicators rated on a point scale. For quantitative interpretation of the results, a scale was used to aggregate individual indicators into generalized indices of digital maturity, digital readiness, and digital potential.

Each indicator was assessed on a three-level scale reflecting the absence, partial, or systematic use of relevant digital solutions. The values obtained were aggregated within their respective blocks, and the results were normalized to enable comparative analysis among small agribusiness entities of varying sizes and specializations.

The results were interpreted by classifying enterprises according to their level of digital maturity (low, medium, high), which made it possible to form an analytical basis for customer segmentation and justification of strategic decisions in the field of digital transformation of agribusiness.

Based on the questionnaire survey results and the structure of Remsintez LLC's customer base (a supplier of agricultural machinery), the indicators of digital transformation for small agribusiness entities were assessed (**Table 2.1**).

Table 2.1 Distribution matrix of small agribusiness entities in the context of digital transformation

Groups	Low Digital Maturity (0–40)	Medium Digital Maturity (41–70)	High Digital Maturity (71–100)
High digital readiness (71–100)	**Segment A** Potential clients: – readiness: 80–100 pts; – maturity: 0–40 pts; – potential: 50–70 pts	**Segment B** Existing clients: – readiness: 80–100 pts; – maturity: 41–70 pts; – potential: 60–80 pts	**Segment C** Digitally advanced clients / adoption leaders: – readiness: 85–100 pts; – maturity: 71–100 pts; – potential: 80–100 pts
Medium digital readiness (41–70)	**Segment D** Passive or formally interested enterprises: – readiness: 41–70 pts; – maturity: 0–40 pts; – potential: 40–60 pts	**Segment E** Potential "middle-tier" entities: – readiness: 41–70 pts; – maturity: 41–70 pts; – potential: 50–70 pts	**Segment F** Potential digital drivers: – readiness: 41–70 pts; – maturity: 71–100 pts; – potential: 60–80 pts
Low digital readiness (0–40)	**Segment G** Traditional enterprises with no digital motivation: – readiness: 0–40 pts; – maturity: 0–40 pts; – potential: 20–40 pts	**Segment H** Insensitive to digital changes: – readiness: 0–40 pts; – maturity: 41–70 pts; – potential: 30–50 pts	**Segment I** Technically mature but unready: – readiness: 0–40 pts; – maturity: 71–100 pts; – potential: 40–60 pts

Source: visualized by the authors of this study

In particular, small agribusinesses in the group of potential customers are characterized by a high level of digital readiness, a low level of digital maturity, and an average level of digital potential. It indicates a positive managerial perception of digital transformation and a willingness to implement digital solutions, despite their limited use in economic activities. At the same time, small agribusinesses that are actual customers of the supplier typically have a high level of digital readiness, an average level of digital maturity, and an average (with a tendency to increase) level of digital potential, which is due to the practical experience of using certain digital technologies and interacting with the supplier of equipment and services. The gap between digital readiness and actual digital maturity confirms the need for a comprehensive assessment of these parameters. It justifies suppliers of agricultural equipment taking on the role of partners and catalysts in the digital transformation of small agribusinesses.

The matrix of small agribusiness entities in the context of digital transformation categorizes them according to two standardized indices: digital readiness and

digital maturity. Potential small agribusiness customers typically combine high digital readiness (71–100 points) with low digital maturity (0–40 points), which corresponds to segment A. Actual small agribusiness customers are characterized by an average level of digital maturity (41–70 points) with high digital readiness, which places them in segment B. The digital potential in these segments is at medium to high levels (50–80 points), confirming the presence of conditions for the further implementation of digital solutions. Other segments of the matrix illustrate possible combinations of digital maturity and readiness levels and can be used to target appropriate marketing, educational, or consulting strategies.

2.3 Service and consulting model of partnership between resource suppliers and small agribusinesses as a tool for revitalizing rural areas

The effectiveness of the practical implementation of the digital maturity assessment methodology depends on the availability of entities capable of transforming theoretical criteria into specific technological solutions. The issue was studied using materials from a typical supplier of general agricultural equipment, Remsintez LLC.

In today's environment, the process of digital transformation of small agribusinesses is shifting from declarative innovations to practical tools for survival and recovery. Against this backdrop, we are witnessing the natural evolution of Remsintez LLC from a classic service provider and supplier of agricultural machinery to a system integrator and supplier of innovations. This transformation is a direct response to the critical needs of small agribusinesses, for which access to adapted digital solutions is becoming the only real driver of viability amid severe resource constraints and security risks. It is vital for areas that have suffered devastating effects, where the revitalization process is a long-term, time-differentiated revival: from supporting the current sustainability of farms in relatively safe regions to laying the technological foundation for the full-scale restoration of de-occupied lands in the post-war period. It is the application of the latest digital technologies that becomes the "quick start" tool, allowing agribusiness to return to the production cycle as quickly as possible at each stage.

The basis of this process is the formation of a fundamentally new service and consulting model for the operation of enterprises supplying goods and services to small agribusinesses. In the traditional scheme of interaction, the purchase of equipment was the final step in the transaction. Still, in modern agribusiness architecture, it serves as the starting point for long-term consulting and service support. By analyzing the questionnaires of Remsintez LLC customers, it was possible to determine their digital competencies (**Table 2.2**).

Table 2.2 Digital competencies in the profile of respondents: small agribusinesses – clients of Remsintez LLC

Indicator	Self-assess digital competency level as sufficient, %	Recognize the need to improve digital competencies, % within the respective group
Laborers and Production Workers, %		
Incomplete general secondary education	12	2
High school diploma (full secondary education)	53	11
Vocational or technical education	27	13
Higher education – Bachelor's degree	6	91
Higher education – Master's degree	2	99
Management and Owners, %		
Incomplete general secondary education	1	4
High school diploma (full secondary education)	24	27
Vocational or technical education	17	29
Higher education – Bachelor's degree	32	97
Higher education – Master's degree	26	99
Workers with IT experience, %		
Less than 5 years	47	98
5 to 10 years	42	99
10 to 20 years	9	81
Over 20 years	2	83

Source: visualized by the authors of this study

An analysis of the profile of respondents – small agricultural enterprises that are clients of Remsintez LLC – based on the educational and qualification levels of their personnel revealed an internal imbalance in digital culture between management and executive personnel. While there is almost complete awareness of the need to improve digital competencies among managers and employees with higher education (97–99%), most employees directly involved in production do not perceive the development of digital skills as a critical factor in improving the efficiency of economic activity. It creates a structural barrier to the introduction of digital technologies, even when management is ready for change.

It has been established that digital culture in small agribusiness is no longer exclusively a social characteristic linked to education, age, or staff competencies, but is gradually becoming an economically significant commercial and marketing factor.

The level of digital culture directly affects enterprises' ability to perceive, implement, and effectively use modern agricultural technology, digital services, and integrated solutions, thereby determining the attractiveness of the enterprise as a customer and partner for equipment suppliers. In this context, improving digital culture is becoming a necessary targeted investment activity, the feasibility of which is determined not only by social but also by commercial and marketing motives. The formation of a digital culture is becoming a necessary condition for the rational use of financial, organizational, and human resources to ensure the digital transformation of small agribusinesses. Accordingly, the implementation of training programs, service support, and interaction models on the part of agricultural equipment suppliers is not an expense but a tool for increasing market efficiency and the long-term competitiveness of both small agribusinesses and their strategic partners.

The survey results indicate a demand for comprehensive consulting services, with the equipment supplier (Remsintez LLC) and suppliers of plant protection products and fertilizers acting as a single front. Small agribusinesses are not ready to spread themselves thin among different consultants; instead, they seek ready-made technological and organizational solutions – from seed drill configuration to digital application protocols. It confirms that Remsintez LLC's service and consulting model should evolve toward a partnership ecosystem, which is critical for revitalization: small agribusinesses in damaged areas receive not just a machine but a guaranteed technology to restore crop yields.

On the one hand, the management of small agribusiness entities – customers of Remsintez LLC – is characterized by a relatively high level of educational and intellectual training: the total share of managers, owners, and administrators with bachelor's and master's degrees is 58%, while 97–99% of them recognize the need to improve their digital competencies, which indicates a managerial readiness to accept complex management decisions and digital changes.

On the other hand, the technical and digital foundations of most small agribusinesses remain fragmented, as evidenced by the personnel structure of production staff. The predominance of employees with complete general secondary and vocational education (80%), who exhibit a low level of awareness of the need to develop digital competencies (11–13%), creates an internal digital culture gap between management and operations. Under such conditions, digital solutions are perceived as an additional burden rather than a tool for improving efficiency.

The presence of employees with IT experience (mainly up to 10 years) does not compensate for this gap, as digital competencies remain localized among individual specialists and do not become a systemic element of organizational culture. As a result, small agribusinesses find themselves with the potential for digital development

but insufficient internal resources and tools to implement it. It is in this context that the role of Remsintez LLC as an external center of digital and organizational competencies becomes relevant. The company's financial development dynamics – revenue growth from UAH 68,500,000 in 2020 to UAH 146,700,000 in 2024 [19] – create the necessary financial "safety margin" to invest in the development of services, consulting, and methodological support for customers. Remsintez LLC does not limit itself to supplying soil cultivation or sowing equipment; it also integrates digital modules for controlling technological operations, GPS navigation systems, and precision agricultural elements that generate data for decision-making. In addition, Remsintez LLC should provide consulting support to its small agribusiness clients, compensating for their limited internal resources in digital transformation. Under such conditions, digital culture is transformed from a purely social indicator into a commercially and marketing-significant factor that determines the expediency of targeted actions and the use of resources to ensure the digital transformation of small agribusinesses.

The revitalization process enabled by the proposed tools is vital for small agribusinesses. The restoration of agricultural production here begins with technological autonomy. Small agribusinesses that acquire equipment with built-in digital support reduce their reliance on external service centers, which may be inaccessible due to logistical constraints. The service and consulting model involves implementing remote diagnostic systems: Remsintez LLC specialists can remotely monitor the condition of components and assemblies, preventing costly downtime. It ensures the continuity of the production cycle, which is critical to revitalizing rural areas, where every working farm is the foundation of community social stability.

The methodological component of this process includes training client personnel (Digital Skills). Since most small agribusiness managers have secondary, specialized, or higher education, they can quickly master working with cloud tools and government digital services, such as the State Agricultural Register or the Diia platform. Consultants support this process by helping small agribusinesses integrate technical data with accounting and management programs. It will enable small agribusinesses to achieve the level of transparency and efficiency characteristic of extensive agricultural holdings without incurring high costs for their own IT infrastructure.

An essential part of the revitalization toolkit is financial and investment consulting. The service and consulting model can offer clients ready-made calculation models for equipment payback periods, taking into account regional specifics, soil conditions, etc. Support for investment decisions using the service and consulting model includes assistance in preparing documentation for obtaining grants for restoration, which is critical for businesses affected by hostilities. In such cases, digital transformation becomes a tool for "cloud autonomy": storing all documentation, field maps,

and production history in secure repositories ensures that, even if the office or archive is physically lost, the business can quickly resume operations in a new location or after the situation stabilizes.

The technology stack offered by a service and consulting provider should also include solutions for ecological land revitalization. The use of modern sowing complexes with digital control of sowing depth and rate enables the implementation of conservation tillage technologies (mini-till, no-till), which help restore soil fertility. It creates a long-term effect on sustainable development, where digitalization is not an end in itself but a means of preserving the main asset of agribusiness – land.

Thus, the organizational and technological tools for service and consulting support form a comprehensive cycle of support for small agribusinesses, beginning with the identification of farm needs, continuing with the provision of intellectual technology, and culminating in ongoing consulting support. This model ensures the transformation of a "passive" small enterprise into an "innovation-active" entity capable not only of surviving in crisis conditions, but also of becoming a driver of revival. Revitalization in this context is a complex outcome: it includes the restoration of jobs, growth in tax revenues, and an increase in technological levels.

The service and consulting model for resource providers integrates digital services, consulting, and training into the traditional technology supply chain, enabling companies to shift from a transactional customer interaction model to a partnership model focused on long-term shared value creation. In this model, the digital culture of customers becomes an element of large businesses' marketing strategy, and investments in its development serve to expand the market and increase consumer loyalty.

On the other hand, for small agribusinesses, cooperation with a large, technologically advanced partner creates a real opportunity to overcome resource, personnel, and institutional constraints that complicate or prevent the independent implementation of digital solutions. Given limited access to specialized IT personnel and financial resources, organizational and technological support serve as a compensatory role, enabling the integration of digital tools into production and management processes without a significant increase in transaction costs.

In this context, digital technologies cease to be merely a tool for automating individual operations and become drivers of business model transformation towards service orientation, the formation of partnership ecosystems, and the development of a circular economy. For small agribusinesses, this means a transition from the fragmented use of digital solutions to a systematic model of value creation based on long-term digital interaction with partners [20].

The result is an asymmetrical but mutually beneficial model of interaction, in which the resource partner serves as a provider of digital knowledge, technologies,

and services. In contrast, small agribusinesses serve as a testing and implementation environment. This model not only reduces the risks of digital transformation for small agribusinesses but also provides a multiplier effect for the partner-provider by expanding the customer base, deepening customer engagement, and forming stable long-term relationships.

Thus, digital transformation in the agricultural sector is becoming systemic. Digital culture is ceasing to be an internal characteristic of an individual business entity. It is transforming into an inter-entity economic factor that determines the effectiveness of partnership models, the feasibility of investments, and the sustainability of the agricultural economy amid structural and technological challenges.

The authors of the study consider it appropriate to apply the Index of Index of Strategic Customer Engagement (ISCE), which will allow assessing the readiness of small agribusinesses to integrate into partner digital ecosystems and use joint planning and consulting services. Calculating this index based on data from Remsintez LLC enables the identification of demand for digital integration, which, in turn, serves as a prerequisite for increasing the digital maturity of agribusinesses and forming long-term partnerships.

The proposed approach illustrates the readiness of small agribusinesses to transition from a transactional model of interaction with equipment suppliers to a partnership model that involves joint planning, consulting, and the cooperative use of material and technical resources. The ISCE calculation, based on a questionnaire survey of Remsintez LLC customers, revealed established demand from small agribusinesses for integration into service and digital ecosystems. This readiness is seen as a prerequisite for the growth of digital maturity in agribusiness, as digital consulting and shared platforms contribute to the development of management competencies, improve decision-making quality, and rationalize equipment use, while ensuring the formation of long-term partnerships and stable supplier demand.

The Index of Strategic Customer Engagement (*ISCE*) is calculated using the following formula

$$ISCE = \frac{N_{cons} + N_{coop}}{N_{total}}, \tag{2.1}$$

where N_{total} – total number of surveyed customers; N_{cons} – number of customers who expressed interest in receiving consulting support; N_{coop} – number of customers willing to participate in shared equipment usage (machinery sharing).

All indicators are normalized on a scale from 0 to 1.

Interpretation of values:

– $ISCE \to 0$: customers are focused solely on one-time equipment purchases (transactional model);

– $ISCE \approx 0.5$: service-platform demand is emerging;

– $ISCE \to 1$: customers are ready for an ecosystem-based interaction model.

The ISCE calculation, based on a questionnaire survey of small agribusiness representatives who are clients of Remsintez LLC, accounts for the average readiness of employees across different categories. Among production workers, it is about 17%; among managers and owners, 68%; and among employees with IT experience, 97%. Weighing these indicators by the share of personnel, it is possible to obtain an integrated ISCE

$$ISCE \approx 0.39.$$

This indicator shows that small agribusinesses are moderately ready to transition to a partnership model of interaction. The most significant potential for increasing digital maturity lies among production workers, whose readiness remains relatively low. In contrast, managers and IT workers demonstrate a high level of readiness to participate in service-digital ecosystems. This result confirms the potential to enhance the effectiveness of digital consulting and sharing technologies to develop management competencies, optimize decision-making, and build long-term partnerships.

The basic Index of Strategic Customer Engagement (ISCE) reflects the level of readiness of small agribusiness entities to transition from a transactional model of interaction with equipment suppliers to a partnership model. At the same time, within the service and consulting model based on the materials of Remsintez LLC, such interaction is not limited to a unilateral effect. Still, it produces a synergistic effect, manifested in the mutual strengthening of the economic, organizational, and technological impacts for both parties.

To quantify this phenomenon, it is advisable to supplement the basic ISCE index with a synergy coefficient that accounts for the level of digital development of small agribusiness entities.

The synergy strategic customer engagement index ($ISCE_S$) is proposed to be determined by the formula

$$ISCE_S = ISCE \cdot \left(\frac{DR + DM + DP}{3} \right), \tag{2.2}$$

where *ISCE* – basic Index of Strategic Customer Engagement; *DR* (Digital Readiness) – normalized index of digital readiness of small agribusiness entities; *DM* (Digital

Maturity) – normalized index of digital maturity; *DP* (Digital Potential) – normalized index of digital potential.

All indicators are normalized on a scale from 0 to 1.

The proposed synergy index reflects not only the client's readiness for partnership, but also the real ability of this interaction to generate added value. Thus:

– if *ISCE* is high, but the level of digital maturity and potential is low, the synergy effect remains limited;

– if *ISCE* is combined with a sufficient level of *DR*, *DM*, and *DP*, the partnership model provides a disproportionately high growth effect for both parties.

The average values of the normalized indicators of digital development of small agribusiness entities are characterized by:

– high digital readiness;

– average level of digital maturity;

– average digital potential.

Under these conditions, the integral factor $(DR + DM + DP)/3$ approaches 0.6–0.7, which allows us to estimate the synergy index at the level of

$$ISCE_S \approx 0.2 - 0.3.$$

The result indicates a moderate but economically significant synergistic effect arising from the interaction between Remsintez LLC and small agribusiness entities.

For small agribusinesses, the synergistic effect manifests itself in:

– accelerated growth in digital maturity;

– reduction of transaction and operating costs;

– increased efficiency in the use of equipment and resources;

– access to consulting and training services.

For Remsintez LLC, synergy provides:

– growth in repeat sales and service contracts;

– increased customer loyalty;

– reduced costs of attracting new customers;

– transformation of the business model from a technology supplier to a digital solutions integrator.

Adding a synergistic component to the strategic customer engagement index allows to move from a static assessment of partnership readiness to a dynamic evaluation of the effectiveness of digital interaction. $ISCE_S$ reflects the ability of the service and consulting model to generate added value within digital ecosystems and can be used as a tool for strategic planning of the digital transformation of small agribusinesses.

2.4 Conclusions

The study confirmed that the implementation of innovative digital technologies in small agribusinesses in Ukraine is a critical factor in ensuring their competitiveness, economic stability, and sustainable rural development. In conditions of high uncertainty caused by global economic transformations and military challenges, digital transformation is becoming not only innovative but also adaptive and restorative, especially for small agribusinesses operating in frontline and de-occupied territories. The use of digital solutions enables the optimization of economic processes, increased efficiency in resource management, reduced losses, and rapid response to changes in market conditions and natural and climatic factors.

At the same time, the study's results demonstrated that digital maturity is a key factor in the successful implementation of technological innovations. Meanwhile, the digital potential of enterprises determines their capacity for "leapfrog" development, provided that existing resources are purposefully mobilized. The assessment of digital maturity in small agribusinesses revealed a significant gap between management's relatively high digital readiness and the low level of actual digital maturity among production staff. This imbalance creates a structural barrier to the full utilization of digital technologies. It necessitates a comprehensive approach that combines training, service-consulting support, and the integration of digital platforms into daily operations.

It has been proven that a high level of digital culture among managers creates the prerequisites for strategic planning of digital changes. However, the lack of a corresponding level of digital competencies among production personnel reduces the return on investment (ROI) of implemented technological solutions and slows down the digital transformation process. This factor is particularly critical for small agribusinesses operating under conditions of labor shortages, logistical constraints, and the heightened security risks characteristic of frontline and de-occupied territories.

The study also confirmed the high efficiency of Remsintez LLC's service-consulting model as a vital tool for supporting and revitalizing small agribusinesses. This model provides comprehensive business support ranging from needs identification and the supply of digitally equipped machinery to ongoing consulting, staff training, and remote monitoring of technological processes. As a result, small agribusinesses gain the opportunity to enhance operational efficiency, reduce the risks of downtime and losses, and integrate into partner service-digital ecosystems that would otherwise be inaccessible under isolated operating conditions.

The economic impact of the digital transformation of small agribusiness is multidimensional. First, agribusiness entities can reduce production and logistical costs,

optimize the use of equipment and material resources, and increase labor productivity. Second, the implementation of digital solutions expands opportunities to attract investments, participate in grant programs, and join partnership initiatives, which is particularly relevant for businesses affected by military actions. Third, the development of digital potential facilitates the creation of new jobs in service maintenance, IT support, and agrotechnology, thereby positively impacting the socio-economic development of rural territorial communities.

The social impact of digital transformation is reflected in the cultivation of an innovation culture, the enhancement of managerial and professional competencies, and the provision of access to modern knowledge and technology in remote areas, including those near the frontlines. Improving digital culture helps attract young professionals, supports intergenerational knowledge transfer, and fosters more motivated and agile workforces. Simultaneously, the implementation of digital technologies fosters precision agriculture, resource efficiency, and environmentally responsible practices, aligning with the principles of sustainable development.

An essential element of the comprehensive impact on small agribusiness is the environmental effect, which is increasingly significant amidst land degradation, climate change, and growing anthropogenic pressure on agricultural landscapes. The use of digital technologies – specifically precision farming elements, machinery monitoring systems, agronomic analytics, and digital resource accounting – promotes the rational use of mineral fertilizers, crop protection products, fuel, and water resources. It reduces environmental risks, minimizes unproductive losses, and mitigates the negative environmental impact of agricultural production.

For small agribusinesses, particularly in frontline and de-occupied territories, digital solutions also function as critical tools for ecological stabilization and recovery. Resource scarcity, damaged infrastructure, and disrupted traditional supply chains necessitate the most efficient and frugal use of available land and material resources. Digital planning and control systems minimize excessive soil tillage, optimize technological operations, and reduce the risk of land degradation – factors vital to post-war recovery.

The environmental impact of digital transformation is markedly synergistic, manifesting through the interaction between small agribusinesses and providers of machinery and digital services. Within the Remsintez LLC service-consulting model, digitally equipped machinery, supported by analytical services and staff training, not only increases economic efficiency but also cultivates environmentally responsible production practices. For the supplier, this translates to expanded demand for modern, resource-saving technologies; for the small agribusiness,

it results in mitigated environmental risks and alignment with the principles of sustainable rural development.

In summary, the environmental impact of the digital transformation of small agribusiness is manifested through reduced negative environmental footprints, increased efficiency in the utilization of natural resources, and the establishment of prerequisites for the long-term ecological sustainability of agricultural production. Combined with its economic and social effects, this confirms that digital transformation is an integral tool for implementing sustainable development principles. Furthermore, partnership-based interactions with machinery and service providers ensure a multiplicative, synergistic outcome for all participants in the agricultural ecosystem.

Partnership-based interaction between small agribusinesses and providers of agricultural machinery and digital services is significant in the digital transformation process. Within such a partnership, a synergistic effect is formed: the digital readiness and potential of the agribusiness are amplified by the supplier's service and technological capabilities. In turn, the supplier gains a stable customer base, increased loyalty, and a long-term, sustainable business model. For small agribusinesses operating in challenging conditions, this synergy reduces managerial uncertainty, improves the controllability of production processes, and accelerates the pace of digital transformation.

The study indicates that the effectiveness of digital transformation in small agribusiness directly depends on the alignment of digital readiness, digital maturity, and digital potential. Enterprises with high digital readiness but low digital maturity require intensive consulting and educational support. In contrast, entities with both high maturity and potential can serve as innovation leaders and the core of regional digital agroecosystems. It provides a foundation for developing differentiated support strategies tailored to each agribusiness's specific level of digital development.

Consequently, a comprehensive assessment of digital readiness, maturity, and potential is a necessary prerequisite for effective transformation.

It enables:

– an objective determination of the enterprise's current state and development priorities;

– the creation of targeted training and consulting programs;

– the optimization of investment and technological decisions while minimizing risks;

– the strengthening of partnership-based interaction with machinery and service providers to promote the sustainable development of rural communities.

In conclusion, the digital transformation of small agribusiness – implemented through integrated technological and service-consulting models while leveraging the synergistic effect of partnerships – is more than just a tool for economic growth. It is a mechanism for enhancing agricultural resilience, fostering social revitalization, and recovering rural territories amidst wartime and post-war transformations.

Promising areas for further research include assessing the multiplicative and synergistic effects of digital transformation, its impact on the environmental sustainability of agricultural enterprises, and the integration of digital solutions into state support systems for small agribusiness.

Conflict of interest statement

The authors declare that there is no conflict of interest in relation to this paper, as well as the published research results, including the financial aspects of conducting the research, obtaining and using its results, as well as any non-financial personal relationships.

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Data availability

The data that support the findings of this study will be made available by the authors on reasonable request.

Use of artificial intelligence statement

The authors have used artificial intelligence technologies solely to verify the correctness and consistency of the English translation of the manuscript in an academic style. In particular, the authors used the generative language model ChatGPT (OpenAI, GPT-5.1 Thinking) for language checking and minor stylistic refinement. The authors bear full responsibility for the content of the final manuscript; the AI tool is not credited as an author and is not responsible for the reported results.

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Authors' contributions

Volodymyr Silchenko: Conceptualization, Methodology, Empirical research design, Data analysis, Writing – original draft.

Lesia Kononenko: Conceptualization, Theoretical framework, Supervision, Writing – review & editing.

Vira Savchenko: Validation, Formal analysis, Interpretation of results, Writing – review & editing.

Alla Karnaushenko: Data curation, Literature review, Formal analysis, Visualization, Writing – review & editing.

Yuliia Hlavatska: Language editing, Academic writing support, Writing – review & editing.

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