Agriculture Digitalisation as an Economic Growth Indicator (A Comparison of Private Farms in Ukraine and Germany)

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Abstract: The article topic relevance is caused by the exclusive place of the agricultural sector in the Ukrainian economy, so its development will have a significant impact on the agro-industrial complex productivity and on efficiency of the state economy as a whole. The effectiveness of digital technology is confirmed by the example of developed countries, including Germany, the indicators of enterprises which in this article are the basis for comparison with Ukrainian subjects of state management. The article aim is to determine the necessity and substantiate methodological recommendations on implementation of the rural economy digitalisation as an indicator of economic growth in the agrarian economy sector based on the comparison of private farms of Ukraine and Germany. In the research, the general scientific methods were used, including the method of analysis, synthesis, and formalisation; method of comparative analysis; SWOT-analysis; PEST-analysis; graphical and statistical analysis. The research and analysis have allowed proving the necessity and grounds of theoretical and methodological recommendations on the active implementation of digitalisation in the industry. It was found, that for the efficient and safe process of digitalisation, it is necessary to improve the legislative basis for its support, to provide state support for the implementation of actions on digitalisation; improvement of access to information for Ukrainian farmers; creation of conditions for constructive dialogue with foreign scientists; stimulation of investment in science, technology; training of scientists and assessment and minimisation of risks that may be associated with implementation of digitalisation activities.

Keywords: Agricultural sector; digital technology; information technology; private enterprises.

1. INTRODUCTION

Agriculture has always played a major role in Ukraine's economy, with agrifood products accounting for close to 40% of the country's total exports, and the share of agriculture in GDP reaching 10%. This contributes to a high proportion of highly productive soils and low labour costs, especially for skilled workers; relatively low taxation of agricultural production; easy access to markets – Western and Eastern Europe, the Near East, Central Asia (Rekunenko, 2017). However, the Ukrainian agricultural sector lags far behind the developed countries, in particular Germany, in terms of the information technology use in agriculture, which has a negative impact on its efficiency and, consequently, reduces the potential productivity and profitability. Due to favourable geographical, climatic and resource conditions, Ukrainian farmers do not fully utilise the potential of the sector, while digitalisation of production can significantly facilitate, accelerate, and increase the enterprises efficiency.

The issue of digitalisation of agriculture is relatively new and continues to evolve in line with the rapid progress of science, particularly information technology. However, this problem has already been studied by a large number of Ukrainian and foreign authors, including: N. B. Demchyshak, O. O. Radukh & V. M. Hryb (2020); Y. O. Sydorov (2020); N. Y. Podolchak, O. I. Bilyk & Y. V. Levytska (2019); Y. Voloshchuk (2019) and others. Researchers have reached an agreement on the necessity of digitalisation processes and have been developing methods of its implementation, but in their works, there is still an understudied topic about the "places of vulnerability" in the implementation of digital technologies. The possible negative effects of digitalisation have not been fully considered or taken into consideration: difficulties may be related to political, economic, social, technological and other factors that potentially complicate the negative introduction of innovations, changing the vector to a phased, gradual implementation of them with a reasonable definition of the terms of each one. It is necessary to look at the problem based on the benefits of digitalisation and controversial aspects of its implementation to make recommendations that will consider the desired state and the real possibilities of the Ukrainian economy.

The obvious need for digitalisation is associated with a number of organisational issues in the implementation process. First, it is advisable to identify the role of government in innovation activities and the level of its influence on the process. The necessary condition for a more active development

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of the process of digitalisation of the rural economy is the state policy of support and stimulation of these processes and the creation of a suitable legal and regulatory framework (Sydorov, 2020). Secondly, to assess the impact of the above factors on the ability and readiness of farmers to innovative transformations. Thirdly, to analyse the efficiency of digitalisation on the real application of developed countries, which is hampered by limited information, lack of desire of foreign enterprises to disclose these or other activity aspects. Precision farming in Germany faces a range of problems. The main one is that farmers are reluctant to exchange information from their sensors with outsiders: other farmers, service providers, dealers and equipment manufacturers (Malinowski, 2018). The resolution of the above-mentioned problems will make the digitalisation process safe, efficient and economically profitable for both the state and individual farming units.

Hence, the aim of the article consists in determination of necessity and substantiation of methodical recommendations on implementation of digitalisation of rural economy as the indicator of the economic growth in agrarian sector of economy on the example of comparison of private farms of Ukraine and Germany. This determines the object of the research – private farms of Ukraine and Germany, whose indicators are the basis for the development of the methodology of digitalisation of the agricultural economy.

2. MATERIALS AND METHODS

The research involved the following general scientific methods: method of analysis, synthesis, and formalisation – to determine theoretical aspects of the investigated problem; method of comparative analysis – to determine the vector of improvement of the desired level of the specified indicators; SWOT-analysis – to identify threats, weaknesses, opportunities, and hazards in the process of digitalisation; PEST-analysis – to determine the impact of political, economic, social, and technological factors in this process; graphical and statistical analysis methods – for the comparison and visualisation of the information obtained. The experimental basis for the study was privately owned enterprises in Ukraine and Germany belonging to the agricultural and industrial complex.

The study of the problem requires a comprehensive theoretical and methodological approach, which includes both theoretical substantiation of the obtained analytical findings and quantitative factual data of the business entities of the industry, and was conducted in three stages:

1. The theoretical basis of digitalisation was investigated, the existing methodological approaches and recommendations for the implementation of innovative activities in the process of state management of agribusiness enterprises were analysed. This stage included identification of the role of the state in the implementation of innovation activities and the level of its influence on the process, which allows identifying the interfaces and capabilities of Ukrainian agricultural enterprises to carry out the process of digitalisation;
2. The second stage involves a comprehensive analysis of the impact of political, economic, social, and technological factors on the implementation of innovation, which facilitates the disclosure of its strengths and "weaknesses" or problems that may confront Ukrainian agrarians on the way to progressive statehood. The disclosure of the above-mentioned factors was implemented through the use of PEST-analysis, while the assessment of strengths, weaknesses, opportunities and threats was carried out using SWOT-analysis as the most useful and demonstrative tool for identifying these aspects in the implementation of digitalisation;
3. The third stage proves the efficiency of digitalisation in practice, using the example of Germany as a developed country with a highly efficient way of managing agriculture. Digitalisation itself plays a significant role in the success of this country, as evidenced by the quantitative indicators obtained in the course of the study, the efficiency of digitalisation in various aspects of the German operations, from optimised document management to the use of new sensors, digital maps, and other digital technologies for an optimum choice of pesticides, herbicides, fertilisers, etc.

After the third phase of the research, the key result is created – the methodological recommendations for implementation of digitalisation in Ukraine, taking into consideration the level of state support, threats, possibilities of the industry and some of its units. The developed methodological recommendations on the implementation of digitalisation in the management of Ukrainian agricultural enterprises will increase the efficiency and minimise the risks of this process in the agricultural sector of Ukraine.

3. RESULTS

The absolute feasibility and necessity of digitalisation of the Ukrainian economy requires clarification of key terms such as "digital economy" and "digitalisation" itself, and also the legal and regulatory basis for this issue. Digital economy is a type of economy characterised by active implementation and practical use of digital technologies for collection, storage, processing, transformation, and transmission of information in all spheres of human activity (Tulchynska & Korzun, 2020). The era of information technology calls for digitalisation of all aspects of human life – from lifestyle to state-level innovations and economic transformations, which, without a doubt, affect the agricultural sector. The Concept of Development of Digital Economy and Society of Ukraine for the period from 2018 to 2020 (2018) and the approval of the action plan for its implementation (hereinafter – the Concept) defines digitalisation as the forcing of the physical world with electronic and digital devices, means, systems, and the establishment of electronic communication between them, which in fact enables integral interaction between the virtual and the physical, thus creating a cyber physical space.

The transition to digital economy is not just the choice of individual agrarians or farming units – it is a state-level

issue, as stated in the present Concept, "With a systematic state approach, digital technologies will significantly stimulate the development of an open information society as one of the essential factors for the development of democracy in the country, increased productivity, economic growth, and improving the quality of life of Ukrainian citizens". The Concept also includes the main objectives, principles, and areas of digital development, financing of digitalisation, and an action plan for its implementation. It should be noted that the Concept emphasises the necessity and importance of digitalisation of the agricultural sector itself, and the list of activities for the implementation of the Concept includes a paragraph on the "development of digital farming and digitalisation of the agricultural sector". Financing of digitalisation activities within the framework of the mentioned Concept is decided to be carried out at the expense and within the limits of the state budget.

A study of the content of the Concept has allowed concluding that the state is gradually and systematically introducing digitalisation in all spheres of life of the citizens and the country. However, legal support for the process of digitalisation of the agricultural sector requires further development, as evidenced by the research of some scientists. For example, Y. O. Sydorov (2020) proposes a few stages of such development: "The first stage, must be the adoption of the sectoral Roadmap for Digitalisation of Agriculture. At the next stage, either the development of special legislative provisions as part of a separate law on innovative development of the agricultural sector, or even the adoption of a separate law on digitalisation of the agricultural sector is proposed". Taking into consideration the unfortunate position of the agricultural sector in the Ukrainian economy, it is worth considering that the agricultural sector may or may not be among the most important beneficiaries of measures to improve operations as it has one of the largest shares in Ukraine's GDP and exports.

As a continuation of the above, it is advisable to consider another important state decision – the adoption on March 31, 2020 of the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Regarding the Agricultural Land Mobility" (2020). The law contains both positive and possible negative consequences for the agricultural sector of the country. Supporters of the Law note the following benefits of its adoption: gradual formation of the market price for land, increasing budget revenues, increasing the efficiency of state land management, and attraction of capital to the agricultural sector of the economy. Opposition to the state's decision suggests a range of such risks, as an increased social discontent through a perception of "unfair" purchase and sale of land, especially among opponents of the opening of the land market; monopoly status of certain entities on the land market; development of the "grey land market" as a result of the high level of corruption in the state, loss of budget revenues (Pokalchuk et al., 2021). In the context of digitalisation of the agricultural sector, the adoption of this law has potential benefits, in particular encouraging investment in agriculture allows the use of the funds for the development and implementation of information technology.

Hence, a provisional conclusion can be made. Where it is possible and feasible to replace the physical mode of operation with a more efficient digital one, digitalisation measures should be implemented. At first glance, this obvious logical assumption may turn out to be excessive in practice, in view of the presence of a list of factors that can hinder or accelerate the digitalisation process. This allows proceeding to the second stage of the research – analysis of political, economic, social, and technological factors influencing the process of digitalisation implementation and identification of strengths and weaknesses, opportunities and threats to this process.

The analysis of the impact factors and the balance of all positive and negative aspects of the digitalisation process was carried out by using PEST- and SWOT-analysis. The PEST-analysis identifies which political, economic, social, and technological factors have the greatest impact on the business entities. The SWOT-analysis reveals strengths, weaknesses, opportunities, and threats to the business. The results of the PEST-analysis are presented in Table **1**.

Table 1. PEST-Analysis of the Digitalisation of the Ukrainian Agricultural Sector.

Political	**Economic**
1. Adoption of the Ukrainian Digital Economy and Society Development Concept for the period from 2018 to 2020. 2. Approval of the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Regarding the Agricultural Land Mobility" of March 31, 2020. 3. Minimisation of legislation, possibility of adopting new legislative decisions. 4. High level of political instability, military conflict.	1. The share of the agricultural sector in the GDP of the country is close to 10% and in exports – 40%. 2. Ukraine has the largest amount of agricultural land in Europe. 3. The investment-friendly nature of Ukrainian agriculture.
Social	Technological
1. Unpreparedness of agrarians to switch to innovative farming. 2. Comparison with competitors, digitalisation for survival in the market. 3. The societal desire for healthy nutrition.	1. The integration of the world economy. 2. The reluctance of foreign agrarians to disclose information obtained through digitalisation. 3. Difficulties in sharing information between individual software products, lack of unification.

Source: Demchyshak et al., 2020; Official web portal…, 2020; Rekunenko, 2017; Shabatura, 2019.

As shown in Table **1**, the first identified political factor is the adoption of the Concept of Ukrainian Digital Economy and Society Development for the period from 2018 to 2020 (2018). The main effect that influences the digitalisation of the agricultural sector of Ukraine is a plan of actions for digitalisation presented in the document, which will be financed at the expense of the state budget. Approval of the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Regarding the Agricultural Land Mobility" (2020),

will also have a significant impact on the active implementation of digital technologies in the agricultural sector by encouraging investment in it. The tightness of legislation has a significant negative effect on digitalisation, but not always, since it leads to a high level of ambiguity. Political instability, in particular the military conflict, have devastating consequences, which could lead to the digitalisation process being cancelled or halted for an unspecified period of time.

Economic factors are playing into the hands of the digitalisation of the agricultural sector. Its high share in the country's GDP and exports confirms the priority of the agricultural sector among Ukrainian sectors of the economy and justifies the costs of digitalisation. The fact that Ukraine has the largest amount of agricultural land in Europe, but is underproductive compared to the rest, makes it necessary to digitise with a further increase in efficiency and productivity. The investment attractiveness of Ukrainian agriculture is due to its low labour costs, productive soil, favourable geographical location, and other aspects.

Among the social factors, the fact that some farmers for various reasons are not ready to switch to innovative farming is also important. These reasons include an attachment to traditional farming methods and the idea that there is no need to change things when everything is already working and the process has already been established. However, as noted in another factor, the implementation of digitalisation can be forced when it comes to survival in the market as a whole – when the competitors are still ahead, who use advanced information technology, if there is a falling demand, decreased productivity and, as a result, the profitability. The third factor – societal desire for healthy nutrition – is particularly relevant in recent times when the public wants to live healthy and therefore wants to receive healthy products that are not contaminated by chemicals. Hence, there is a need for a digital calculation of the exact amount of these products.

Technological factors include the integration of the world economy, which encourages farms to meet today's high standards of quality and productivity, which cannot be achieved without the use of high technology. The reluctance of some foreign agrarians to disclose information obtained as a result of using new software products, as another technological factor, complicates the analysis and use of foreign experience. Difficulties in information exchange between individual software products also complicate the digitalisation process and need to be solved at the creation and upgrade stage of the software products.

The identification of factors that influence the process of agribusiness management should be continued by identifying strengths and weaknesses, opportunities and threats, that may emerge in the process of digitalisation under the influence of certain political, economic, social, and technological factors. For this purpose, a SWOT-analysis was used, the results of which are presented in Table **2**.

Table 2. SWOT-Analysis of the Digitalisation of the Ukrainian Agricultural Sector.

Strengths	Weaknesses
1. A high proportion of productive soils. 2. Relatively low cost of labour. 3.The largest amount of agricultural land in Europe. 4. Availability of state support for financing digitalisation activities.	1. Agrarians' unwillingness to transition to the new realities of state management. 2. There may be difficulties of a financial, organisational, and social nature, due to the need to retrain and train personnel. 3. Lack of financial provision. 4. limited use of foreign experience.
Opportunities	Threats
1. The high investment attractiveness of the Ukrainian agricultural sector. 2. Support for developed countries, in particular the EU countries. 3. The availability of highly qualified staff who are ready for training.	1. The modernisation of legislation, the adoption of laws and other regulations that are unreasonable or unfavourable for a certain part of rural households. 2. High political instability in the country, military conflict, uncertainty about the future of agribusinesses and the agricultural sector as a whole.

Source: Created by authors.

The SWOT-analysis demonstrated, that digitalisation is beneficial in many ways because the available resources – highly productive soils, low labour costs, large amounts of agricultural land, and the availability of state support create favourable conditions for the implementation of the strategy. The available opportunities – investment attractiveness, the support of developed countries, and the presence of highly qualified staff only reinforce the previous message. But one cannot overlook the weaknesses and threats that can derail the process at any stage. While the weaknesses in Fig. (**2**) can be mitigated by good management decisions, threats at the level of the individual business entity cannot be eliminated. Given the intense political conflict and the lack of cooperation from the aggressor country, it is very difficult to plan a digitalisation strategy and tactics. However, progress will not stand still even in the most important times for Ukraine, so the development of science and technology, innovative processes, in particular the digitalisation of the rural economy, cannot be postponed "until the end of time", it is necessary to create a platform for the future development and transformation of the Ukrainian economy.

Germany has not been accidentally chosen as an example to compare its agricultural sector with that of Ukraine – the agricultural and industrial complexes of the two countries are very similar in many respects, but there are also significant differences. This relates to the availability of resources, support from the state, the productivity of the agricultural sector, etc. The similarity of climatic, geographical, and other conditions, and also considering the differences between Ukrainian and German economies will contribute to the formulation of effective methodological recommendations for the implementation of digitalisation in Ukrainian enterprises, using German enterprises as an example.

90% of German agricultural and industrial enterprises are privately owned, while in Ukraine these are 75-83% (Rekunenko, 2017). This fact, among others, significantly affects the efficiency of land use, including the implementa-

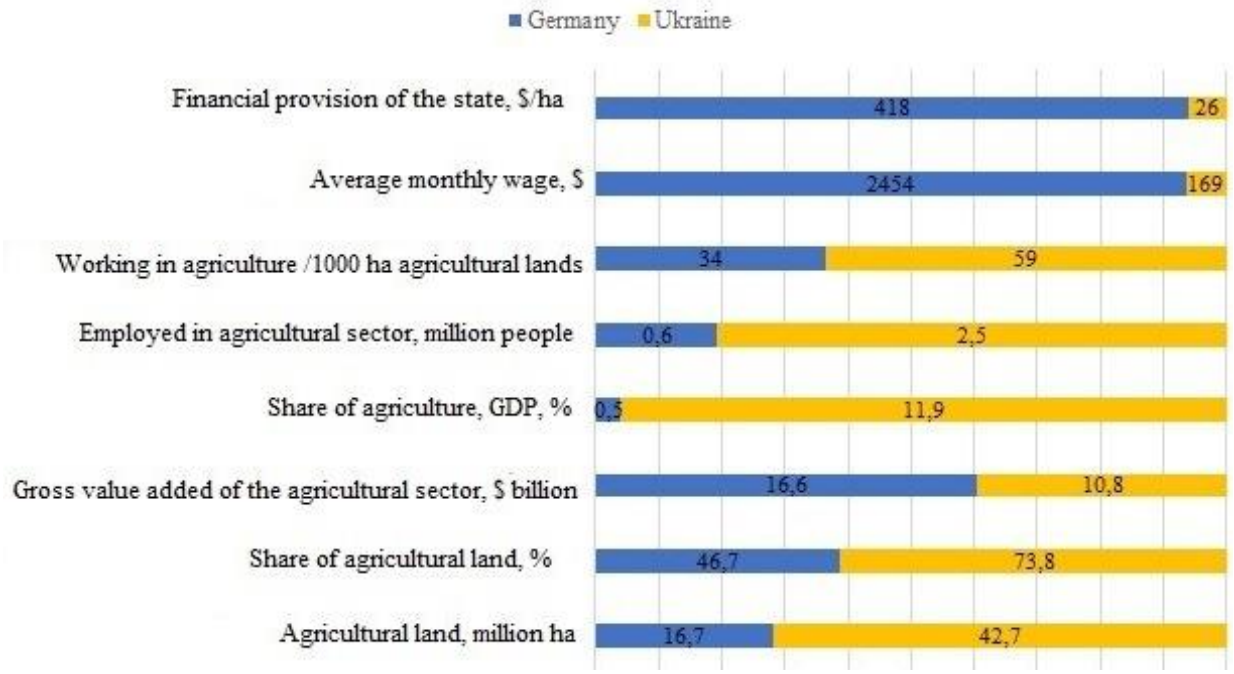

Fig. (1). Main indicators of the agricultural sector in Ukraine and Germany.
Source: Rekunenko, 2017.

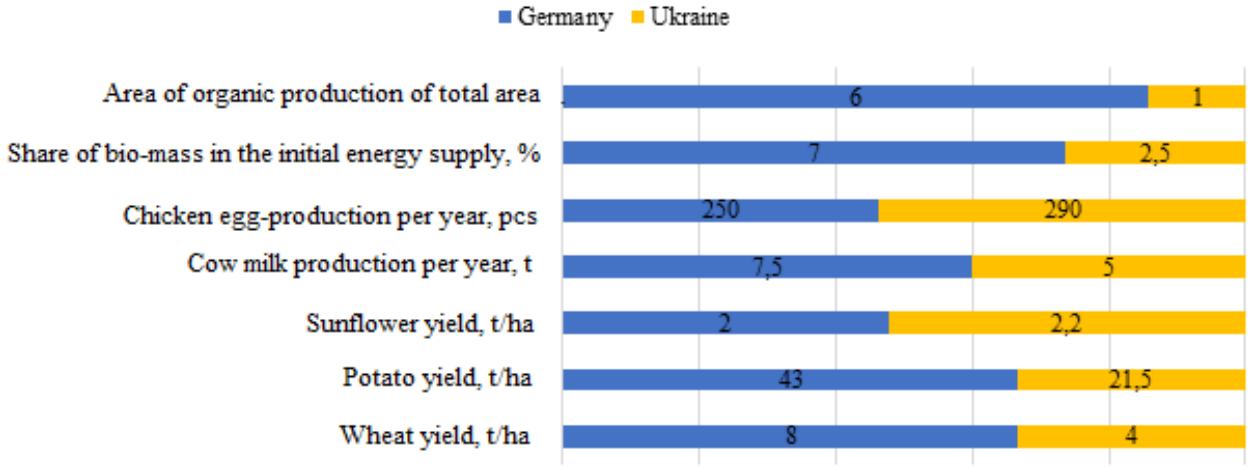

Fig. (2). Comparison of yields of Ukrainian and German agriculture by individual items.
Source: Rekunenko, 2017.

tion of digitalisation, so it is appropriate to consider other key indicators of the agricultural sectors of Ukraine and Germany in order to lay the groundwork for further conclusions (Fig. **1**).

Due to Fig. (**1**), the financial support from the state and the average monthly wage in Germany is several times higher than in Ukraine. Also, the gross added value of the agricultural sector is higher in Germany. However, Ukraine leads by all other indicators: the number of people employed in agriculture, its share in GDP, the share of agricultural land, and others. From this it can be concluded, that on the whole Ukraine outweighs its resource potential – it has everything in its power to run the agricultural sector efficiently with maximum efficiency, especially considering that this sector is the leading one in the country. In this context, of particular interest is the comparison of the productivity of the agrarian sectors of the two countries, which is demonstrated in Fig. (**2**).

Fig. (**2**) shows a vivid advantage in the productivity of German farms, excluding the indicators of chicken egg-production and sunflower yield, where Ukraine takes the first place. The results of the analysis of Figure **1** and Figure **2** allow concluding that although Ukraine has a great potential in agricultural sector, it does not fully utilise it, unlike the Czech Republic, which uses its resources as efficiently as possible because it has, behind others, a high level of state support and highly developed technologies. This confirms the necessity of increasing the support by the state of agricultural enterprises of Ukraine and implementation of digitalisation in the agricultural sector in order to increase efficiency,

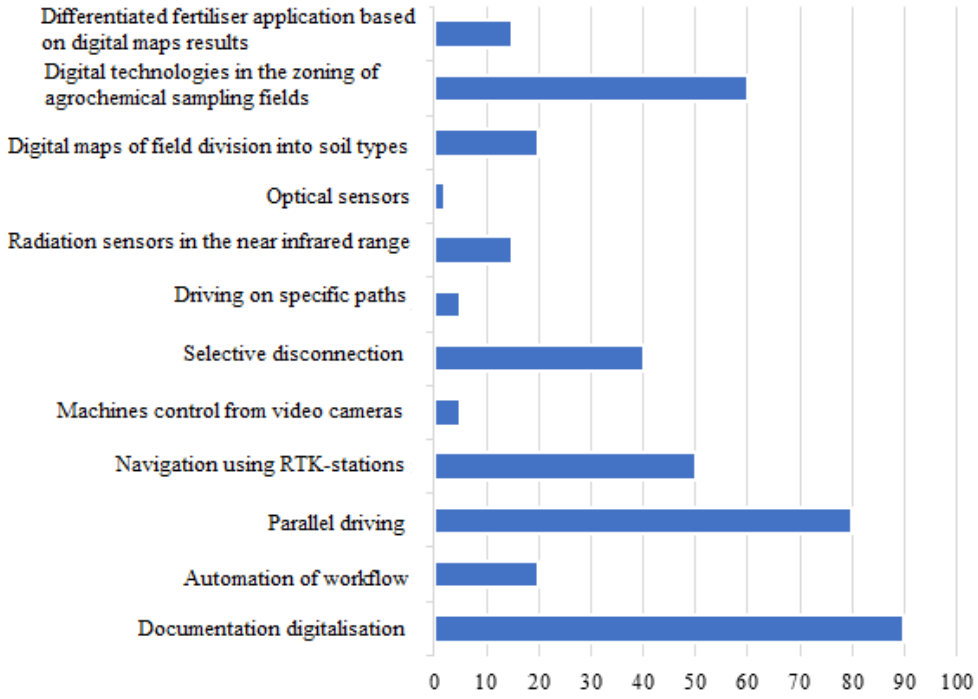

Fig. (3). Proportion of German agribusinesses using modern digital technology by type.
Source: Malynovskyi, 2018.

productivity, and realisation of all available possibilities of the agricultural and industrial complex of the country. However, while government decisions are beyond the control of individual economic entities, digitalisation measures can be implemented independently within the limits of the current legislation, even at the level of private farms.

As a continuation of this analysis, it is of particular interest to find out which digital technologies are used in German agriculture, and how many farmers adopt them in their operations (Fig. **3**).

As can be seen from Fig. (**3**), the most widespread (90%) among digitalisation activities in German farms is the documentation digitalisation, which significantly speeds up the management process in view of the reduced time for "paperwork". The second place among the information technologies used by German farmers is taken by parallel driving (80%) – the method of driving agricultural machinery with a driver who picks up the satellite signal and steers the machine in the desired direction. This technology helps to increase the quality of production through optimum application rates of crop protection products as it prevents missed or repeated applications at the same location and prevents overexposure of crops to chemicals. The third most popular technology (60%) is digital technologies in the zoning of agrochemical sampling fields. The agrochemical analysis is an important aspect of agriculture as it allows laboratory determination of soil chemistry, identification of the amount of useful and detrimental substances contained in plants, and thus estimate the quality of products. 50% of German agricultural industries are using RTK stations which are designed to correlate the accuracy of the satellite signals and accompany the growing process from the preparation work up to the immediate harvest. Also, the use of plot switching (40%) is widespread, especially for growers, which also optimises the amount of inputs to the crop and saves the cost of the farms.

4. DISCUSSION

The material investigated in this article and the comparative analysis carried out allows proceeding to the formulation of methodological recommendations for the digitalisation of Ukrainian agricultural enterprises.

1. Further development of legal support for the digitalisation of Ukrainian agricultural enterprises, the adoption of relevant laws that provide for the development of information technology in the agricultural sector with the provision of financial support from the state.

The development of legal support is not accidentally at the forefront of methodological recommendations, as the creation of an appropriate legislative framework and an adequate financial support for digitalisation activities on the part of the state is a prerequisite for its implementation as a whole. Political and legal aspects of digitalisation have been examined by international scientists (Ehlers et al., 2021; Fielke et al., 2019; Fielke et al., 2020; Kosior, 2019; Matthews, 2018; Rotz et al., 2019). Interestingly, in developed countries with more established legislative practices, where there are already a sufficient number of enacted laws on digitalisation, researchers often look at the inverse process – how digitalisation affects politics. It is noted (Ehlers et al., 2021), that digitalisation has a direct impact on three dimensions of politics. Firstly, digitalisation can be based on inputs (fertilliser taxes), technologies and methods (buffer stores), or outputs (nitrate quotas). It may also target farm units (e.g., fields) or higher levels (e.g., whole farms or water management estates

and landscapes) to achieve a related result such as nitrate content in drinking water as a policy objective. This is described by measuring correlation between inputs and outputs where digital technologies can generate new data and establish strong correlations between inputs, outputs, and targets. Secondly, digitalisation indirectly affects the political aspect of location specificity, which is facilitated by digital georeferencing. Thirdly, digital monitoring and databases indirectly influence the inter-hour measure of flexibility which requires interchanging of regulated volumes and rates of taxes or subsidies (Ehlers et al., 2021). Based on the above, it can be argued that in developed countries more attention is paid not to how to ensure digitalisation from a legal point of view, but how digitalisation directly affects the country's policies. It can be therefore concluded, that digitalisation in developed countries has already reached such a scale that it requires some regulation. In particular, it can have an impact on prices, taxes, subsidies, and the environment, therefore, developed countries must address not only what digital measures need to be introduced or which ones are most effective, but also what impact these measures will have on all spheres of the economy and people's lives. The way these measures are to be implemented, or which ones are most effective, but also what impact they will have on all spheres of business and on people's lives. As for Ukraine, it is necessary, on the one hand, to identify and implement the most effective digitalisation measures with the expectation that they will be financed and, on the other hand, taking into account the experience of foreign partners, immediately estimate and determine the probability of certain positive or negative effects on the economy, society, environment, etc.

2. Providing enterprises with the necessary information that can be supplied by the state for more efficient management of the economy – data from satellites, sensors, video surveillance, etc, Information on new technologies used abroad and the creation by the government of favourable conditions for dialogue and consultation with foreign experts.

The issue of access to information has always had supporters and opposition in politics, sectors of the economy, individual states, etc., as confirmed by studies by international authors (Linsner et al., 2021; Garske et al., 2021; Sarker et al., 2019; Klerkx et al., 2019). S. Linsner et al. (2021) note in his paper that "The role of transparency in the sphere is a controversial issue. While transparency brings benefits, particularly for supply chain actors, such as retailers, it also creates conflicts of interest for higher-order actors such as suppliers, who fear price increases. The asymmetry of the market position between small and medium-sized enterprises and large agricultural businesses seems to aggravate these conflicts. For successful digitalisation implementation, without the need to leave certain actors behind, mechanisms must be put in place to make relevant data accessible to all without disclosing the operational data of individuals to prevent fraud. Confidentiality of information and especially the fear of its violation through the introduction of new technologies and business practices remains an important factor in the implementation of digitalisation in agriculture. Several enterprises of varying sizes need to identify whether the benefits they promise outweigh the disadvantages they are avoiding. In particular, discretion is a double-edged sword: it builds confidence but can also be intimidating in the event of disclosure of commercial secrets to third parties". This conclusion explains the weakness of the digitalisation process identified above, in particular the reluctance of farmers to disclose information for public use. However, by adopting competent governmental decisions and mutually beneficial arrangements, it is fully possible to create more favourable conditions for increasing access to information, providing advisory services by foreign experts and adopting the experience of leading agribusiness enterprises in other countries.

The availability of information means that there is a need for professionals who can use it effectively. This applies especially to highly skilled workers – analysts, programmers, who will be able to interpret the data they receive in an appropriate manner. Therefore, the third recommendation concerns investment in science, technology, and training of such professionals, who can develop effective software products and conduct analytical research, particularly in the agricultural sector.

3. Increased investment in science, technology, and training and retraining of specialists in the agricultural and industrial sector and computer technology specialists in the development of software support for the digitalisation of agriculture and the creation of opportunities for software products to exchange information between each other.

As mentioned above, information technology is nowadays an integral part of everyday life and the economy, its specific sectors and business units. Software products ensure the accuracy, speed, efficiency, ease of operation, and other aspects of the activities of large and small businesses. Nowadays, in the development of computer technology, training and upgrading skills programmers, purchasing the necessary software products there are made great investments from both the state and the private sector economy. The studies by international experts (Ayaz et al., 2019; Bu and Wang, 2019; Friha et al., 2021; Gómez-Chabla et al., 2019; Haseeb et al., 2020; Jin et al., 2022; Kassim, 2020; Maddikunta et al., 2021; Song et al., 2020; Suma, 2021; Sushanth and Sujatha, 2018; Yang et al., 2021) often include the terms "smart agriculture" or "IoT" (Internet of Things) in agriculture. The study (Yang et al., 2021) presents three types of regimes for the development of "smart" agriculture:

1) precision farming (characteristic of the United States) – characterised by large scale, significant climatic impact, and an open environment. The main trends are development of Polish farming, replacement of manpower by mechanisation, reduction of manpower;

2) object-based agriculture (used in Japan) – industrial model, closed environment, and controlled conditions. The main trends are to better crop genes, improve production conditions, and increase the level of land use;

3) orderly farming (Western European countries) – business model, data management. The trends are to increase the scale of agriculture, develop agricultural management, and increase productivity (Yang et al., 2021). As for the Ukrainian specificities of farming, the third mode of "smart" farming – orderly farming – is the most suitable for Ukrainian agricultural enterprises. However, for the successful implementation of this regime, Ukraine needs to create a settled scientific, information, and technological platform for the imple-

mentation of appropriate measures. An example of such a platform is presented in the work of L. D. Vodyanka and T. P. Yuriy (2020). The platform proposed in the research takes into consideration point support tools for small and medium-sized enterprises, provides for the use of quality information resources and the possibility of introducing technological equipment into the activities of agricultural enterprises. To increase the efficiency of the platform, it is also necessary to include highly qualified personnel from the fields of science, technology, and computer technology with the provision of their requalification or training with a focus on the agribusiness sector. Moreover, the scope of training should not only take into consideration the development of digital technology in the agricultural sector, but also include courses for analysts, who will be able to identify the strengths and weaknesses of specific approaches, assess the risks that will inevitably arise in the digitalisation process, and suggest ways to minimise them. This conclusion leads to the formulation of the following recommendation related specifically to the minimisation or reduction of potential risks in the process;

4) Minimising or offsetting by the state of possible risks that may arise in the process of digitalisation, e.g., potential short-term loss of productivity in the course of implementation of new technologies and the creation of new workplaces for workers who may remain unemployed due to automation of production, etc.

The last recommendation should be considered in more detail since the identification of risks and possible negative consequences of digitalisation is one of the key tasks of the research. Risks that may arise in the digitalisation process are a common concern for many researchers studying this topic and have been discussed in studies (Bahn et al., 2021; Hilbeck and Tisselli, 2020; Lioutas et al., 2021; Stroissnig, 2021; Zscheischler et al., 2022). E.D. Lioutas et al. (2021) identified a number of following risks or negative aspects of digitalisation:

1) social and ethical, political: concentration of power in the great Ag-Techs (companies whose activities are focused on the development of technology in the agricultural sector), the creation of an elite, confidentiality, and ownership of these farms, The difference between small and large farmers, developed and developing countries, remote and central areas, the limited ability of workers with low qualifications to adapt to new conditions;

2) ecological: specialisation of farms, which can lead to a decrease in biodiversity value, loss of traditional crops, degradation of intra-industrial resources;

3) cultural: separation of farmers from traditional farming culture, technofication of agriculture (Lioutas et al., 2021).

In view of the identified risks, the implementation of any stage or even of digitalisation should be accompanied by a preliminary comprehensive assessment of the possible consequences not only for the rural economy, but also for society and the environment. This conclusion coincides with the results of the study of foreign experience in the implementation of digitalisation activities, which was mentioned in the discussion of the first point of the guidelines – in the West, practitioners pay a lot of attention to the study of how digitalisation affects all aspects of society, so it is appropriate to draw on international experience and examples, and to consider the potential risks ahead. This proves the feasibility and validity of the preceding recommendation to increase investment in science and research, as only a highly qualified specialist can identify as accurately as possible the risks and the likelihood of obtaining positive or negative effects from the implementation of digitalisation activities through the use of scientific methods, software, etc.

The analysis of literary sources allowed confirming the validity of suggested methodological recommendations on implementation of digitalisation in agricultural enterprises of Ukraine. Development of legal and financial support, information support, and creation of conditions for the interstate dialogue on the agricultural sector, investments in science, technology, studying, and also predictability and minimisation of possible risks are necessary conditions for effective and safe process of introduction of information technologies into Ukrainian agricultural sector.

Considering that the practical part of the study is limited to the comparison of Ukrainian agricultural enterprises with the enterprises of only one developed country – Germany, it should be noted, that its quantitative results will be different in terms of comparisons with other countries. However, the general methodological recommendations will remain unchanged, as the work of foreign researchers from different countries was used in the process of their development, which increases the practicality of such recommendations.

5. CONCLUSIONS

The conducted study is complex in nature and consists of three stages, which can be summarised separately.

In the first stage, a theoretical basis for digitalisation was defined and the role of the state in this process was established. It was found, that the state has set out a plan of actions for digitalisation and financial support for their implementation, but the legal support for digitalisation is still at a developmental stage and requires further improvement.

The second step, includes a PEST-analysis, which reveals the political, economic, social, and technological factors influencing the digitalisation process. The SWOT-analysis complements the results of the PEST-analysis by identifying strengths and weaknesses, opportunities and threats to digitalisation. It was found that Ukraine has the necessary conditions, resources, and capabilities for digitalisation, but every step in the further process of implementation of specific measures must be made with a strong sense of urgency, since digitalisation, along with the obvious positive consequences for the agricultural sector and the economy of the country, also entails potential threats and risks.

In the course of the third stage of the study, a comparison of digitalisation in German and Ukrainian enterprises was made. It was found, that in many respects the agricultural sectors of the countries are similar to each other in terms of climatic, geographical, and other conditions, but there are also significant differences, primarily concerning the support of the state, the level of technology development, and the productivity of the state. It was found that Ukraine has a lot more potential than Germany – agricultural land area, employment in agriculture, and other. However, the productivi-

ty of Ukrainian agricultural and industrial farms is lower, which is a result of the lack of technology, financial support from the state, and legislation.

The study of the normative and legal framework made it possible to assess the relevance of innovations. Today, digitization is a necessary aspect in all spheres of society. Ukraine is actively integrating into the world community and implementing the digital economy. Digitalization of the economy of the agricultural industry is especially relevant for Ukraine as an agrarian state. Facilitation of this process is regulated by legislative and regulatory acts and involves the allocation of funds from the state budget. Although the digitalization process is gradual, the Concept of its implementation still needs improvement.

Another positive factor for the digital globalization of agriculture is the financial issue of forming the market price for the purchase and sale of land, which has its own risks and advantages. However, an important contribution is the incentive to invest.

The position of Ukraine at the European level leads in the field of agriculture in terms of the number of plots. A high share of GDP and demand in the country's exports is a significant factor for accelerating and improving the digitization of the agricultural sector. Agricultural business is competitive, which also affects the pace of digitization. This is a systematic approach to studying all the nuances in order to avoid public dissatisfaction, taking into account political, economic, social and technological factors and reintegrating traditional methods of farming into the latest digital ones.

In order to more widely take into account the beneficial factors of agribusiness, its activity in Germany was investigated. Thus, it was concluded that the implementation of the latest technologies in the digitization of documentation, improvement of information technologies and the introduction of digital technologies in the zoning of agrochemical fields are priorities. Currently, Ukraine only aspires to such means.

As a result of this research, methodological recommendations have been developed, which primarily relate to the development of legislative support and the provision of financial support for the digitalisation process on the part of the state, providing Ukrainian farmers with the necessary information and creating favourable conditions for constructive intergovernmental dialogue with farmers from other countries, investments in science, technology, and training of highly qualified specialists, including software development and ensuring communication between software products, and also assessing and minimising the potential risks that may arise as a result of the implementation of these or other digitalisation measures.

Further research could focus on the development of specific actions for the legal support of digitalisation and a detailed study of the risks of implementing specific digitalisation actions and ways to minimise them.

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