Methodological foundations for the application of the competency-based approach to personnel development in the context of agriculture digitalisation

Olga Malinina[1]* and *Anastasia* Gurieva[2]

[1]PhD in economics, Don State Technical University, 344000 Rostov-on-Don, Russia
[2]PhD student, Admiral Ushakov State Maritime University, 353913 Novorossiysk, Russia

Abstract. The article presents the main innovations introduced in global agriculture. The trends and problems of digitalisation of agribusiness in the Russian Federation are highlighted. One of the significant and complex problems facing the digitalisation of agriculture is the lack of human resources. At the same time, the set of employees, mainly low-level workers involved in the work of agribusinesses, does not have the appropriate level of professional competence taking into account the applied digital technologies. The necessity and significance of state support in the framework of technological breakthrough in the agro-industrial complex of the country is considered. The author's position with regard to the personnel of the agricultural industry is defined. Personnel as a key element needs constant improvement of professional competences, which can be achieved by applying the improved methodological approach to the formation of competences of different levels of specialists at the stage of their training in an educational institution. Based on the opinions of managers of agricultural enterprises, obtained as a result of the survey and study of the Professional Standard, competences for three levels of employees of agricultural enterprises are proposed. The most important competences and the levels of difficulty in mastering these competences are highlighted.

1 Introduction

Agriculture is one of the important sectors of the economy, which has enormous opportunities and potential. The opportunities are represented by broad-based government support aimed at introducing various digital technologies into the core activities of the sector.

Today our country is in difficult conditions, when accelerated growth of technological development of the world economy and tougher competition for new knowledge are of particular importance [15].

Digital technologies make it possible to control the full cycle of crop or livestock production: “smart” devices measure and transmit parameters of soil, plants, microclimate, etc. Information from sensors, drones and other equipment is analysed by special programmes. Mobile or online applications come to the aid of farmers and agronomists to determine a favourable time for planting or harvesting, to calculate fertiliser schemes, to forecast the harvest and much more.

Farmers can manage digital technologies in their personal account via a web interface or mobile app. It displays all field logs and recommendations generated by the system.

Over the past decade, the world has witnessed the rapid evolution of new technologies, an evolution that has initiated the dawn of the Industry 4.0. This new intersection of the digital, physical, and biological spheres allows high-tech solutions like robotics, cloud computing, and artificial intelligence to proliferate [7].

Smart agricultural and horticultural systems are used to optimize production inputs and maximize outputs. In general, smart farming and the use of modern technologies in the agricultural and horticultural sector include the automation and digitalization of businesses. Digitalization increases the flow of information across the value chain, and digitalization technology has the potential to make crop production more efficient, environmentally friendly, and adapted to market changes [11].

The purpose of the formation of human resources is to ensure the sustainable development of the agricultural sector. There is an urgent need to change the system of personnel training in knowledge and skills, taking into account the conditions of digitalization for all groups of employees. In this regard, a number of measures supporting the industry are needed, including economic, organizational, and legal levers. Optimal provision of the country's agricultural sector with personnel is a multifaceted and complex task, the solution of which can be achieved through the effective use of state regulation tools.

* Corresponding author: olya.rudakowa2011@yandex.ru

2 Results and Discussion

As a result of digitalization, the productivity of the agriculture sector can be improved. Artificial Intelligence (AI), by combining data, such as soil moisture, weather data, and plant status information collected by in-field sensors, satellites, and drones, can inform farmers about the most economical way to utilize resources (such as water, fertilizer, and pesticides), potentially improving crop production, food quality, and farm incomes [11].

Every year, there is a shortage of highly qualified specialists in the sphere of agro-industrial complex, as entrants are not attracted to work in the agricultural sphere. There is a stereotype that the agricultural industry is not promising, which is far from true [14].

An analytical review of statistical data has shown that the number of employees in the agricultural sector has decreased over the last decade. At the same time, the growth rate of this indicator is decreasing. At the same time, the number of organisations of the agro-industrial complex has increased.

To support the formation of a digital space in the agricultural environment, the state has developed a programme for the development of agriculture until 2030, which outlines the so-called IT standard.

The agricultural industry is generally considered one of the most conservative among other industries. However, at this point in time, the growth of digitalisation is accelerating.

Agricultural firms can also use BDA to determine how much food to produce, store, and distribute, thereby assisting in creating a food/nutrient security information system [1].

The agricultural industry in its development provides for the availability and continuous accumulation of highly specialised, in-depth knowledge, which forms its fundamental basis. Effective production and management decisions are based on the accumulated modern academic knowledge and doctrines together with innovative digital technologies.

Apart from the state, various other stakeholders are interested in agriculture. A striking example is the banking sector represented by the JSC “Russian Agricultural Bank”, which actively participates in the involvement of professional staff.

Digitalisation has the potential to threaten or blur role boundaries within the agricultural industry as the professional identity of farming is moved away from manual labour and into an office, with farmers functioning more as managers and supervisors instead of doing hands-on work on the farm [2].

The state needs to develop, adopt and implement long-term programmes for agricultural staffing at all levels of agro-industrial complex management, to improve the regulatory and legal framework for state support and development of human resources, including regional legislation, to develop mechanisms of public-private partnership in solving tasks of managing human resources in rural areas.

The following are identified as the main directions for the introduction of digital technologies in the agricultural sector:

- modelling and forecasting;
- digital twins;
- artificial intelligence, including machine learning;
- the Internet of things;
- unmanned aerial vehicles;
- unmanned agricultural machinery and robotics;
- satellite communication and positioning systems;
- Big Data processing;
- sensors and beacons with a satellite data transmission channel;
- technologies for accounting for fishing activities (for equipping vessels of the fishing fleet).

Current universities provide an insufficient training of graduates in the field of agriculture. Modern realities confirm the shortage of personnel in the agricultural sector. The digitalisation process has made it possible to fill the shortage of professional personnel by attracting IT industry specialists who can use their knowledge to organize effective business in agriculture.

It should be noted that there is still a need to improve the system of training agricultural workers to work in the digital space of the industry. The solution to this problem should be realised at all official levels. Teaching students on an innovative basis requires strengthening and modernizing the material and technical base and infrastructure of agricultural educational institutions.

Another problem is that the accumulated experience and knowledge must be passed on to the younger generation. Today, existing digital technologies can solve this problem and valuable industry knowledge is being made publicly available.

The main task in the field of IT technologies in the agricultural sector is to implement digitalization and automation in all business processes of production activities, which will reduce losses, increase profits and improve the efficiency of operations in general.

However, at the same time, you should take into account the influence of factors such as harvesting, storage, processing, transportation, business negotiations with buyers and sale of goods.

Digital solutions in the agribusiness system are built to maximise the cycles observed in agriculture.

To gain the trust of farmers, agricultural suppliers must adapt their offerings to the needs of the industry. It is particularly important to ensure non-standard pricing.

The new generation of “digital farmers” will have to solve emerging issues, who will be able to effectively combine the academic base with the leading developments of industry 4.0.

Agricultural performance at the country level can be achieved if the following tasks are solved:

- to recruit employees in the industry who have industry-specific professional knowledge and skills combined with digital technologies;
- to improve staff selection methodologies to better understand and assess the capabilities of applicants. This includes assessing not only hard skills, but also soft

skills. It is soft skills that are responsible for the ability to acquire knowledge of digital technologies.

In 2020, the structure of the educational level of specialists of the main services was formed, with the largest share of persons without professional education in the veterinary (9.2%), engineering and technological (8.6%) services, the largest number of specialists with higher education in the economic (81.7%) and agronomic (73.2) services. A significant share of specialists have secondary education in accounting (40.0%) and veterinary (37.9%) services.

Due to the increasing volume of digital data, there is, in parallel, an increasing demand for data science specialisations. Nevertheless, due to the newness of the professional role and its interdisciplinary nature, there is still not a full alignment between the expectations of employers and the credentials of job seekers, affecting employability. These employer expectations are reflected in job advertisements, which detail, among other things, a position's duties, tasks, and activities, as well as an applicant's required hard and soft skills, competencies, qualifications and work experience [6].

The process of digitalisation of the agricultural sector is accompanied by a reaction of the labour market. The strategy for the development of the country's agricultural sector obliged employers to revise the technology of search and selection of personnel.

Priority is given to people who possess both modern professional competencies, personal ambitions and creative skills. Such people are able to implement innovative agribusiness practices. Such personnel are able to transform existing business processes.

In this regard, it becomes necessary to create a system for monitoring human resources using digitalization technologies. The work of the system will be aimed at recruiting personnel at the regional and federal levels. Educational institutions of higher, secondary vocational and additional education should be connected to the monitoring system.

New skill requirements can displace or replace some forms of workers, such as low-skilled migrant labour, as manual labour opportunities decline alongside a rise in digital management opportunities [4].

In our opinion, it becomes necessary to familiarise future employees with modern digital innovations in the process of teaching fundamental knowledge.

One of the ways to obtain comprehensive knowledge is to change the Professional Standards, on the basis of which secondary and higher education institutions form curricula and a competence base for future graduates.

An integral element of every job function should be a focus on the application of already developed digital technologies.

Using the level of education of the workforce as the classification criterion, we define the employees with the education of bachelor and above as the high-skilled workforce (high), employees with the education of specialist as the medium-skilled workforce (mod), and employees with the education of high school and below as the low-skilled workforce (low) [9].

Consequently, the nature and synergy of people's hard and soft skills in a determined context are considered essential for the sustainability and quality of a labour market [5].

Agricultural production is the most vulnerable business, as it is highly dependent on weather and natural phenomena. That is why, it is difficult to structure the business processes of this industry.

Agricultural operations involve several major business processes: production, logistics, sales, analysis and management.

These skills are not only enablers of other skills in the taxonomy but also drivers of digital business models, digital products/services, and smart/IT-based manufacturing activities [10].

Lack of time, high variability of professional actions and strategies for conditions prediction, determined by awareness of the consequences of emergency situations and personal responsibility, lead to stressful situations, psychological and emotional tension, and, as a result, errors in activity [13]. Therefore, the competencies of employees in the industry must take into account all possible difficulties and problems. The goal of the competency-based approach is for students to master competencies in the learning process [16].

Let's consider the necessary competences for realisation of the business process “production” for three groups of personnel of an agricultural enterprise.

Characteristics of competences are presented from the position of significance and complexity of its mastering [17–19].

Significance (weight) is represented from the maximum possible value equal to 1.

The complexity of mastering the competence is characterised by a maximum value of 100 points and the following levels are assumed:

- from 1 to 30 points: a level of simple, easy mastering;
- 31–60 points: an average level of difficulty in mastering these skills and competences;
- 61–100 points: a high level of complexity (mastering the competence requires deep professional knowledge).

Table 1. Competences for highly qualified personnel in the agricultural sector.

Competences	Weight	Difficulty of mastering
Able to develop advanced plans and technologies for mechanisation and automation of processes using digital innovations	0.3	60/100
Capable of managing production activities in the field of maintenance, repair and operation of agricultural machinery, including those operating on a digital platform	0.6	40/100
Able to test new agricultural machinery	0.1	80/100

Table 2. Competences for qualified personnel in the agricultural sector

Competences	Weight	Difficulty of mastering
Able to organise maintenance and repair of agricultural machinery on the basis of digital platforms	0.3	60/100
Able to organise the operation of agricultural machinery using digital innovations	0.6	50/100
Capable of organising work to improve the efficiency of maintenance and operation of agricultural machinery, including the use of digital technologies	0.1	90/100

The competencies of unskilled personnel are among the most significant in producing results for the agricultural industry, as it is the unskilled personnel who perform the functions directly related to agricultural work in the fields [20].

Table 3. Competences for unskilled personnel in the agricultural sector

Competences	**Weight**	**Difficulty of mastering**
Capable of disassembling and assembling agricultural machinery and equipment, including innovative machinery and equipment	0.1	80/100
Able to perform work on assembly and disassembly of agricultural equipment using IT technologies	0.1	90/100
Able to perform work on repair and adjustment of agricultural machinery and equipment using digital technologies	0.09	60/100
Capable of repairing assemblies and mechanisms of agricultural machinery and equipment	–	–
Able to repair parts of agricultural machinery and equipment	–	–
Able to bench run, test and adjust repaired agricultural machinery and equipment	–	–
Capable of setting up equipment	–	–
Able to carry out technical operation of equipment running on digital platforms	0.4	40/100
Capable of commissioning new equipment based on digital technologies	0.08	70/100
Able to carry out maintenance of agricultural machinery, including machinery operating on digital platforms	0.23	30/100

An important aspect in the formation of competence of future specialists is the experience gained in the application of specialised industry knowledge together with knowledge of modern digital technologies [21].

Analysing the competences of highly qualified personnel of the agricultural industry by surveying the employees of agricultural enterprises, the most important competence was identified: “ability to manage production activities in the field of maintenance, repair and operation of agricultural machinery, including those operating on a digital platform”. At the same time, the mastering of this competence is at a low level of complexity and refers to easily learnt skills [22].

In the group “qualified personnel”, the most significant one was the competence “Able to organise the operation of agricultural machinery using digital innovations”. This competence corresponds to the average level of mastering.

The largest number of employees that are particularly important are those belonging to the unskilled labour force.

The second biggest effect of digitalisation and automation is caused on the type of labour performed by employees. A key consideration is that many formally manual tasks are now performed with the assistance of machinery and new technologies, changing the workflow [8].

This group of personnel must also possess the necessary competences corresponding to this level. In the process of studying the Professional Standard, labour functions have been identified, which should contain skills, actions and knowledge of the basics of digitalisation of the agricultural industry [23, 24].

The most significant competence among the whole list of presented competences is the competence “Technical operation of equipment working on digital platforms”.

When developing the necessary competences in the practical work of an agricultural enterprise, the best performance is represented by the method of “critical incidents”. When applying this method, the algorithm presented in the figure should be used.

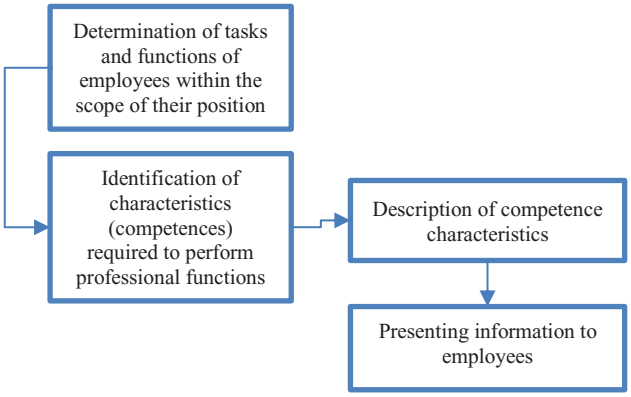

Fig. 1. Algorithm for applying the critical incident method.

The agricultural organisation should establish a scale of competencies. This scale provides for the following levels: unacceptable, basic, standard and expert. The characteristics of each level are presented in the table below.

Table 4. Characteristics of competence levels.

Level	Level characteristic
Unacceptable level	The competence is formed at a low level. Indicators of competence are practically not traceable or are demonstrated incorrectly. Negative examples in professional behaviour are observed (more than 20%). The minimum requirements stated in the profile for an employee are absent. There is no aspiration to develop competences.
Basic	Development of competences below the stated requirement. Control over fulfilment of professional tasks is required. Interest in further development is observed.
Standard	Competence development is more in line with the employee's stated profile. The employee makes decisions in production situations, does not need supervision, shows interest in further development of the competence level.
Expert	The development of competences significantly exceeds the required level according to the profile. The employee possesses complex skills, knowledge and abilities. Negative behaviour is absent. He/she is an example for the team. Development of new modern knowledge is required according to scientific and technical development.

3 Conclusion

In the era of technological revolution, innovative IT, automation and biotechnology solutions are becoming significant sources of opportunities to generate additional income for agribusinesses, improve the quality of agricultural products and reduce production costs.

The digital transformation of agriculture brings new working conditions and places greater demands on specialists whose knowledge must be based on informatisation and digitalisation. A key success factor is to have specialists who are able to apply IT knowledge in agribusiness.

Therefore, it is necessary to change the format of knowledge acquisition from the position of the competence-based approach in the field of agriculture at the level of educational institutions. Academic knowledge should be oriented more towards the practical demands of the market.

The new digital systems are expected to significantly reduce raw material procurement costs, reduce the idling time of agricultural machinery, and increase harvesting efficiency.

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