

# Informatization of Astrakhan agriculture under conditions of Caspian states international relations development

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**Abstract**—The paper describes specific features of Astrakhan region’s agro-industrial complex (AIC); shows the necessity of increasing its competitiveness under the conditions of developing international relations of the Caspian states, import of agricultural products from abroad and other Russian regions. Authors consider the use of information and communications technologies (ICT) in the following areas of regional AIC. (a) Ensuring electronic communications between natural and juridical persons. (b) Getting operational data and other information for making and implementing decisions. (c) Accumulating information on AIC and conditions of its activities in computer databases and/or on websites. (d) Providing opportunities for a selective access to this information. (e) Analysis of information on AIC with the use of different approaches, methods and computer programs. (f) Graphical presentation of the analysis results. (g) Planning of the production and sale of products in AIC, developing measures to support agricultural products primary producers and processors. (h) Computer inventory of agricultural land, cattle and poultry stock, etc.; compiling reports on such inventory results. (i) Space and aerial photography of regional land resources; their mapping to assess the state of the soil and harvest. (j) Modelling of the processes, connected with the regional AIC activities. (k) Forecasting of agricultural production, including crop capacity, livestock yield and production prices. (l) Design and construction of AIC facilities. (m) Development and irrigation of lands. (n) On-line control over production processes at different hierarchical levels, including automation of farms and equipment. (o) Training of specialists for AIC. (p) Conducting research for the regional AIC.

**Keywords**—*agro-industrial complex; Astrakhan region, international relations, information and telecommunication technologies, areas of use, training of specialists, information security.*

## I. INTRODUCTION

The development of information and communications technologies (ICT) has an impact on activities of different sectors, including the agro-industrial complex (AIC) of Russia and its separate regions [1]. Certain aspects of informatization (digitalization) of AIC at the national and regional levels have been considered in a number of papers, for example in [2, 3]. However, some questions are studied insufficiently. For example, one of such important questions is the influence of region’s international relations expansion

at informatization processes in regional AIC, their economic and technical development [4] and AIC information security level. That is why the present paper is aimed at making an attempt to close this gap.

## II. MATERIALS AND METHODS

To make the study more precise, the material is considered on the example of Astrakhan region (AR). It has both general and specific features in comparison with other regions of Russia [5, 6], including neighbouring regions.

Different sources were used to select material for the present study [7]. It was the Russian agriculture statistics, available on the website of the Federal State Statistics Service ([http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog/doc\\_1265196018516](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1265196018516)); data from the website of two AR Ministries – Ministry of Economic Development (<https://minec.astrobl.ru/ru/novost/itogi-socialno-ekonomiceskogo-razvitiya-astrahanskoi-oblasti-v-2018-godu>) and Ministry of International and Foreign Economic Relations (<https://mid.astrobl.ru/press-release/podvedeny-itogi-mezhdunarodnoy-i-vneshneekonomicheskoy-deyatelnosti-astrahanskoy>); information materials and news from other websites; scientific papers, incl. from [www.elibrary.ru](http://www.elibrary.ru) and other repositories of scientific and technical information [8].

Standard and “extended” means of the Internet search systems (engines), scientific information repositories, etc. were applied [8].

The paper also includes the authors’ personal experience, gained during their work at AR state administrative bodies, research institutions of the regional AIC, regional universities.

## III. RESULTS

### A. Main characteristics of AR and its AIC under the conditions of developing region’s international relations

As of 01.01.2018, the AR resident population accounts for 1,017.514 people, the regional area is 49.0 thousand km<sup>2</sup>. The gross regional product per capita was 432.600

thousand RUB in 2018, and the foreign trade turnover was 1,257.0 million USD in 2018.

As of 2018, the AR total agricultural area is 2,978.1 thousand ha, including 276.9 thousand ha of arable lands, 83.1 thousand ha of cultivated lands (cereal crops - 15.7 thousand ha, vegetables - 24.2, melons - 8.2, potatoes - 11.3, fodder and technical crops - 23.7). The total yield of agricultural crops (in thousand tons): cereal crops – 35.4; vegetables – 1,292.2; melons – 313.7; potatoes – 331.1. The animal farming production in 2018 (thousand tons): cattle and poultry (carcass weight) – 36.8, milk – 176.3, eggs (million pieces) – 383.1. The AR food self-sufficiency level is 49.1% for “cattle and poultry” meat, 52.7% for milk and 143.3% for eggs. That is why a lot of meat, dairy and other products are imported to AR from other Russian regions and from abroad, including the Republic of Azerbaijan, the Islamic Republic of Iran and more remote countries. It complicates the work of primary producers (PP) of agricultural products (AP) in AR and limits market opportunities for “personal subsidiary plots”.

Agricultural products are sold in AR through procurement organizations, wholesale and retail markets, shops (including chain stores), markets, concession stands / kiosks, sometimes “from cars” (roadside markets).

The region has limited capacities for processing of produced AP. As a result, a significant part of regional AP is taken out from the region in an unprocessed form, and processors lose their potential working places.

The arid climate of the major part of AR requires application of “irrigated agriculture” [9, 10, 11]. A high prime cost of irrigation water for its consumers is determined by the following factors: payment for water, taken from water basins [12]; a necessity to use fish protection systems at “legal” water supply inlets; costs of water transportation to the places of its use; water losses on filtration into the ground when transporting through open channels, etc.

A significant part of transit food cargoes, passing through AR, is transported to the Russian regions that are traditional areas of the AR sales market. The greenhouse cultivation of vegetables in AR in winter is limited by small areas of such greenhouses and a high cost of energy carriers. In relation to selling vegetables during the “warm period” of year in Central and Northern regions of Russia, AR mainly competes with regions of the Southern and North Caucasian Federal Districts, with AP producers from foreign countries, including the Islamic Republic of Iran, the Republic of Azerbaijan, the Republic of Turkey. In these countries, the climate is warmer than in AR and there is more precipitation in many areas. During a warm season, competitive (by prices) supplies of vegetables to Central and Northern Russia are also carried out by Volgograd, Saratov and other regions, located further north than AR. They grow vegetables without artificial irrigation, and the prime costs of products transportation to Central Russia are lower than for AR. However, the annual volume of the watermelons, which are taken out from the AR is still big enough.

The role of fishery in the regional AIC has decreased in comparison with the Soviet period due to reductions in fish

catch by organizations (above all, sturgeon, ordinary fish and sprat) and lowered volumes of fish processing at the territory of AR. However, large volumes of fish are caught by the AR population (not by organizations) for sale, including for off-market sales. Sturgeon and its caviar are very popular abroad. Nevertheless, the volume of their export from Russia is limited by the international “export quotas”, connected with the general assessment of the sturgeon stock condition in the Caspian Sea basin and the activities of plants for sturgeon artificial reproduction. Let us also note an active use of aquaculture technologies for sturgeon farming abroad beyond the Caspian Sea basin, incl. in South Asian countries.

#### *B. Juridical persons that use ICT*

Let us mark out such categories of juridical persons. (1) Governing bodies of the regional AIC – a “relevant ministry” and its subdivisions, including its district offices. (2) Public oversight authorities in the sphere of land-use management, natural resource management and environmental protection, compliance with water legislation, environmental requirements, etc. (3) Primary producers of AP in the spheres of crop and livestock farming, including farms. (4) Veterinary, phytosanitary and technical supervision bodies for assuring quality of marketable AP. (5) AIC processing enterprises (except for fisheries), including the Astrakhan meat packing plant, functioning canned vegetables enterprises, tomato paste producing organizations, etc. (6) Associations of PP of AP and/or AP processors. (7) Procurement and sales organizations. In particular, the chain supermarkets “Magnit” (“Magnit near Your House”, “Family Magnit”) and “Pyaterochka” operate in sufficiently large settlements of the region. Another retail chain is “Lenta”, which has two trade centres in Astrakhan. The retail chains procure a part of the products for sale from local PP of AP as well. In large settlements of Astrakhan region AP are also procured by public catering facilities. Well-timed receiving of information on pricing with the use of ICT is crucially important for trade organizations to ensure profitability of their activities. (8) Project and building organizations that render services to AIC. (9) Suppliers of agricultural equipment and spare parts. (10) Suppliers of seeds, mineral fertilizers, plant protection agents, animal treatment and preventative medicines. (11) Organizations that carry out artificial insemination, veterinary aid to animals, etc. (12) Installation and commissioning organizations that operate in the sphere of AIC. (13) Banking structures (including the regional branch of Russian Agricultural Bank in Astrakhan); credit unions, that render services to PP in Astrakhan region. (14) Insurance companies that operate in the sphere of AIC. (15) Fishing farms, including “fishing associations”, as well as fish processing enterprises. (16) Aquaculture breeding farms – full-system and rearing fishing farms. (17) Organizations of transport, power supply and support services for the regional AIC. (18) Scientific and research organizations: Federal State Budgetary Scientific Institution “Caspian Agrarian Federal Scientific Centre of the Russian Academy of Sciences”; the Caspian Fisheries Research Institute, which is the Volga-Caspian branch of the Federal State Budgetary Scientific Institution “All-Russian Research Institute of Fisheries and Oceanography”. (19) Universities and colleges that train and re-train AIC specialists and run advanced training programmes for them. Regional universities also conduct research for the benefit of the

regional AIC. (20) Companies that develop and introduce software, information systems, databases and websites for AIC organizations ensure information security of such organizations. (21) Telecommunication companies, including mobile network operators and Internet providers.

### C. *Natural persons that use ICT*

Let us mark out the following categories: top management of regions and relevant (for AIC) ministries; heads of other types of organizations; PP of AP, including farmers; natural persons related to rendering services for the AIC; ICT subject-matter specialists, connected with AIC activities; students of regional universities and colleges; school students; rural adult population unable to work; pre-school children living in a rural area. Note the importance of ensuring of ICT-competence of people, related to regional AIC activities, through the work of educational institutions and self-training of specialists and the population.

### D. *Specificity of using ICT in the region.*

(1) Almost all the adult population has mobile phones (smartphones) and actively uses them. (2) The average level of PC use in households and organizations of the region is quite high, though due to the indicators for Astrakhan, its suburbs and other large settlements of AR. (3) The high-speed wired Internet access is possible mainly in Astrakhan and in its suburbs, as well as in some regional district centers (not in every building). Moreover, in many cases only Rostelecom provides internet services in settlements out of Astrakhan. (4) Wireless internet access out of Astrakhan and large settlements is mainly possible through mobile network operators, though they do not provide 4G over the whole territory of the region. Moreover, some areas of AR do not have any stable cellular communications at all. (5) The use of additional receiver-amplifier devices of the GSM standard (passive and active) allows to extend the communication range with base stations up to 15 km or a bit farther, taking into account the flat relief of AR. (6) The CDMA standard, which provides for a larger range of communication in comparison with GSM, is not used by mobile operators in AR. (7) Small organizations and farms form the major part of AP producers in AR. They usually do not show much interest in informatization of their activities due to limited volumes of available resources, lack of ICT-competent workers and frequent lack of necessary conditions for using computers and automated systems, including stable power supply. (8) Only large AIC organizations or their associations in AR have their own websites.

## IV. DISCUSSION

The set of areas of AIC activity informatization, described below, was formed on the ground of the principles of “necessity and adequacy”.

### A. *Ensuring electronic communications between natural and juridical persons*

For this purpose, the following means can be used: smartphones and PC tablets (if the area is covered by mobile network operators) – for voice conversations, sending and receiving of SMS, for bank payments, incl. with the use of additional measures for ensuring information security [13]; laptops with radio modems, incl. with the use of additional receiver-amplifier units to extend the communication range; stationary computers with cable (wire) internet access (for

Astrakhan region – mainly in district centres); satellite radio communication, though it is still too expensive; “asymmetrical Internet”, when information is received from a satellite and “instructions” (commands) are sent through a relatively slow radio-frequency line to a ground receiving station. From such stations the signal is transmitted further through the cable.

### B. *Receiving information, necessary to make and implement decisions in the sphere of AIC*

Types of information: hydrometeorological forecasts (short-term, medium-term and long-term); information on crop and cattle product pricing [14], prices for AIC “consumable materials”; information on conditions for insurance of farm activities, harvest, etc. Smartphones, PCs and other devices can be used to receive the information. Such information can be taken from news, incl. from news messages on specialized websites, from information system databases, subscription newsletters, etc.

Different decisions can be made on the basis of this information, incl. operational decisions made by PP of AP in relation to its processing, storage periods and time of its implementation, procurement of spare parts for the equipment, etc.

### C. *Gathering of information on AIC and the conditions of its activities in computer databases and/or on the websites of organizations*

This type of accumulation is accompanied by the structuring of information and by the designation of the storage descriptors, such as the date of information occurrence, etc. Usually it improves the conditions of access to the necessary information, using search engines of information systems.

The information, placed on a set of Internet sites, can be obtained by applying the Internet search engines with adequate requests, using “advanced search” tools and some other methods.

Now developers of information systems and websites frequently use “adaptive interface” tools to provide convenient work with data for different users (stationary and mobile), using devices with displays of different sizes – including smartphones.

At the regional level, the creation of specialized databases for agribusiness can be undertaken not only by commercial structures, but also by public and municipal administration authorities to provide informational support for the PP of AP.

### D. *Providing users with the selective access to information.*

Different categories of users from agribusiness and related industries may have different rights to access and correct information, including information of commercial importance. In this regard, it is important to ensure information security of agribusiness data (including PP of AP data) posted on websites and in information systems.

### E. *Information analysis using different approaches, methods and computer programs.*

Analysis of the accumulated information on agribusiness can be carried out at different hierarchical levels: for the

region as a whole; for individual sectors of the region, including the dynamics of their indicators; for individual rural areas; for farms of certain categories; for individual farms. Different methods and approaches to information analysis can be used, including mathematical and statistical ones. It is worth noting that most PP of AP usually are not able to use the mathematical methods adequately. That is why computer analysis systems should necessarily include a "default" method of calculations and advising systems in a natural language.

#### *F. Visual representation of the analysis results.*

The presentation of the analysis results should be available to different PP of AP, rural managers, agribusiness professionals and heads of business structures. Visibility can be provided by the following means: software tools, including appropriate selection of charts and graphs; using colors, etc. It should be noted that at least for PP of AP, it may be appropriate to use decision support system (advisory systems), which give certain "recommendations for action".

Despite the multi-ethnic composition of the Astrakhan region's population, it is sufficient to provide background information as well as data analysis results only in Russian.

#### *G. Planning of production and marketing in agriculture, development of manufacturing support measures*

Possible planning objectives: improving self-sufficiency of the region with foodstuff; improving the nutrition of the population according to the climate and existing medical recommendations, a need for increasing competitiveness of the AP produced, including its supplies from other regions of Russia and from abroad.

This type of planning is based on the extensive use of ICT for information obtaining and its analyzing. It can be carried out at different hierarchical levels – from the regional level to specific farms, belonging to the PP of AP. "Non – profit horticultural partnerships", which are used in the cities and large settlements of Astrakhan region are also of great importance. Citizens who own plots in such *partnerships* are interested not only in the protection of buildings and crops (including the use of ICT for remote control), but also in providing automated irrigation of plants on a given schedule or controlled in a remote form – in accordance with air temperature, humidity and receipt of rain waters. For this purpose, in the areas given for cultivation, some storage water tanks can be used, including "drowned" in the ground.

The products produced in such *partnerships* can be used by citizens not only for personal consumption, but also can be sold at the local level. Thus, the work of *partnerships* improves Astrakhan region's food self-sufficiency; allows to "constrain" prices in the regional markets, stalls, trading networks etc. Local authorities support *partnerships* by allocating lands for them, and sometimes help them with the organization of irrigation. The allocation of land and the monitoring of its use are based on the computerized cadastral systems and their databases.

According to the results of the agricultural production planning, state and municipal authorities, as well as banking structures and credit cooperatives, can carry out decisions,

related to information, consulting or financial and economic support for the activities of various types of organizations (including PP of AP) and allocation of land for the organization of farms. Separately, we note the support for the activities of fish farms, which use rearing ponds for breeding fish to market weight and subsequent sale.

#### *H. Computer inventory of agricultural land, livestock, poultry, etc.; reporting of its results.*

Such inventory in Astrakhan region is carried out not only by specialized bodies, that control land use, but also by municipalities, including village councils. In the latter case, the approach applied is based on "door-to-door" inventory of home gardens, livestock, poultry, etc. In Astrakhan region unified software are used for such records with the consistent structure of databases. This provides the possibility of obtaining the necessary summary statistics on the totality of village councils, districts and Astrakhan region as a whole.

#### *I. Space and aerial survey of land and other resources, their mapping*

Space photography (including spectrozonal) of Astrakhan lands is carried out at the "federal level" with the use of specialized satellites. Currently, the resolution of such images is quite high. However, PP of AP usually do not have prompt online access to images directly related to their farm lands.

The accumulation of the results of space photography allows to analyze the processes of desertification, to assess the intensity of pastures usage and the processes of plant growth. It is worth noting that radiosonde observation of the lands (territory) is effective and perspective method to obtain data on the amount of moisture in the surface layer of soil.

An alternative to space survey is aerial survey with manned (including airplanes and helicopters) and non-manned (unmanned) aircraft. During this process, some operational "local" data on the land and crops can be obtained, as well as the information on the potential use of rangelands and the presence of pests of agricultural plants, etc. The collected data, including operational information, can be presented with the use of geographic information systems, including different layers for different types of data. The main problems for this direction of ICT-usage are the low subjective interest of the PP of AP in obtaining this information; a difficult access to it for PP, especially in remote areas (for example, in "sheep herding").

#### *J. Process modeling of agro-industrial complex of the region*

Possible approaches: development of mathematical models, based on systems of differential equations; construction of computer models and implementation of "simulation" processes in making decisions and their implementation; analysis of the "WHAT-IF" type, including financial and economic decisions. For example, such decisions can be accepted in relation to the choice between the independent implementation of agricultural products and its sale to intermediaries [13]. We also note the possibility of using "cognitive modeling" for qualitative and semi-

quantitative analysis of processes in agriculture, socio-economic systems [1], including in rural areas.

#### *K. Forecasting of agricultural production results.*

It can be carried out on the basis of different approaches: with the use of mathematical (computer) methods of analysis for “multidimensional time series”; by constructing systems of ordinary differential equations, describing the processes in the AIC, the subsequent computer simulation of these processes; using expert evaluation of AIC development (in this case it is important to use adequate methods of computer processing of expert evaluations); in the form of combinations of these methods.

#### *L. Design and construction of facilities for regional agro-industrial complex*

Currently, the design processes (including for AIC) are based on the use of automated design systems; computerized budgeting systems for the implementation of projects; computerized methods of “project management”. Therefore, computer-aided design, using “licensed” software, are quite expensive. So the prices for development of new projects of AIC facilities are also high. That is why it is more appropriate for PP of AP and owners of plots in *partnerships* to select projects from the databases of “standard projects”, including those available on the websites. Then such projects are «linked» to specific areas of the territory, i.e. introduction of the minimum changes, considering features of areas in which the facilities, for which the projects are designed, are supposed to be placed. This method is much cheaper than “designing projects from scratch”.

At the same time, construction processes (especially in rural areas) are practically not computerized.

The use of intelligent computer systems (such as “smart home”) is considered to be promising in the maintenance of the constructed facilities of AIC. However, in Astrakhan region such systems are used mainly for suburban “cottage buildings”, affordable only (or generally) for high-income groups of urban population in the city of Astrakhan.

#### *M. Land reclamation and irrigation.*

Land reclamation in the AR is limited due to the relatively high cost of such works. The reclamation of spawning grounds of fishes in the territory of Astrakhan region is of great importance, as well as cleaning channels fish passes for spawn “sliding” to the riverbeds after completing the period of “fishery weeding” during high water period on the main bed of the Volga River and its waterways.

The reasons for the limited use of irrigated lands in the Astrakhan region are mainly economic [9,10]. The use of modern irrigation measures (drip and subsurface irrigation according to air temperature and stages of plant growth) on the territory of Astrakhan region is still quite narrow. At the same time, the organization of such irrigation, taking into account atmospheric temperature and moist conditions, could be a good “automation object”.

#### *N. Operational management of production processes.*

In the Astrakhan region, automation activities are mainly used by large processors of agricultural and fish products. It is almost not used in the farms of small PP.

Main reasons: high cost of automation means management; seasonal nature of the received harvests in the sphere of crop production in the open ground, processing and transportation of its products; the probabilistic nature of the achieved results – especially in the sphere of crop production in the open ground.

#### *O. Training of specialists for the agro-industrial complex of the region*

Specialists in this area are mainly trained in universities and colleges, situated in the territory of Astrakhan region. In their activities, these organizations widely use ICT; give the necessary knowledge concerning ICT for students; participate in the development of international relations of regions, including in agriculture sphere.

#### *P. Conducting agriculture research and developments in the region*

ICT are widely used while conducting researches, related to the AIC of the region, as well as “mathematical packages” for information analysis of data about AIC functioning, prospects of its development and risks of such development. The studies are mainly carried out in specialized research institutes and universities of Astrakhan region.

However, it is worth underlining that a large number of scientific publications on AIC of Astrakhan region, especially on the fishery industry, is produced by “extra – regional” authors, working in different organizations.

Results of such researches are systematically published in scientific journals and collections of scientific articles, issued in various parts of Russia.

At the same time, joint publications of regional (Astrakhan) authors with foreign scientists on the issue of informatization of agro-industrial complex of the region in the scientific literature practically does not occur. Exception are cases of joint publications of Russian research supervisors and their foreign postgraduate students from the Russian universities.

## V. CONCLUSION

On the territory of Astrakhan region, the informatization level of different types of AIC organizations vary significantly. The lowest level of informatization is characteristic for PP of AP in Astrakhan region. Possible measures to increase the level of informatization at different hierarchical levels of organizations and their groups are quite expensive. At least, some of such measures should be implemented from the budgets of Astrakhan region and its rural areas.

We also note the important role of the development of telecommunications in rural areas of Astrakhan region to provide opportunities for integrated use of ICT.

**REFERENCES**

- [1] A. S. Kahramanov, and I.A Shcherbatov, "System analysis of the agricultural cluster of the region as a socio-economic system," *Caspian journal: management and high technology*, № 4. pp. 20-33, 2016.
- [2] A. I. Altukhov, A. V. Bogoviz, and I. M. Kuznetsov "Creation of an information system – a necessary condition of rational organization of agricultural production," *Advances in Intelligent Systems and Computing*, vol. 726. pp. 800-809, 2019.
- [3] N. S. Zavivayev, and A. P. Mansurov, "Informatization as a condition of effective development of agro-industrial complex Asimuth of scientific research," *Economics and management*, vol. 6.№ 3 (20). pp. 153-155, 2017.
- [4] K. A. Markelov, "Analysis of regional security of Astrakhan region," *International agricultural journal*, .№ 5-6. pp. 51-56, 2013.
- [5] S. A. Dobrolyubov, and V. A. Snytko, "Sustainable development Of the Caspian region," *Bulletin of Moscow University*, №. 1. pp. 99-100, 2015.
- [6] A. A. Tishkov, O. B. Glezer, and V. A. Snytko "Geography and sustainable development of the Caspian sea region" *News of the Russian Academy of Sciences, Geographical series*, №. 1. P. 141-143, 2015.
- [7] K. A. Markelov, Yu. M. Brumshtein, and V. G. Golovin "The process of integration of the Caspian States and their maritime territories: system analysis of information sources and structure," *Bulletin of Eurasian science*. vol, 10, №. 5. pp. 34, 2018.
- [8] Yu.M. Brumshteyn, and E. Yu. Vas'kovskii "The Websites of International Association Organizations in the Science and Engineering Area: Analysis of Their Functionality, Webometric Ranks, and Role in the Scientific Information Space," *Automatic Documentation and Mathematical Linguistics*, vol. 52, №. 3, 4, pp. 157-174, 2018.
- [9] T. I. Alexandrova, "The current situation of irrigated agriculture in the Astrakhan region," *Bulletin of the Caspian sea*, № 1 (16), pp. 33-38, 2017.
- [10] T. I. Aleksandrova, and V. P. Zvolinsky, "Development perspectives of agriculture of the Astrakhan region," *Bulletin Of The Caspian region*, № 4 (15). pp. 56-58, 2016.
- [11] I. A. Nesterenko, "The state and prospects of crop production and horticulture in Astrakhan region," *Gardening and viticulture*. №. 3. pp. 22-25, 2010.
- [12] M. V. Bolgov, and A. P. Demin, "Water-Management and Environmental Problems of the Lower Volga and Ways to Their Solution," *Water Resources*, № 45 (2), pp. 297-305, 2018.
- [13] K. D. Boskebeev, J. K. Alimseitova A. K. Boskebeeva, V. G. Aleksandrovich, and N. V. Vasiliev, "System analysis of risks of livestock farms in the conditions of development of information and telecommunication technologies (on the example of the Kyrgyz Republic and Astrakhan region)," *Caspian journal: management and high technology*, .№ 1 (41), pp. 129-143, 2018.
- [14] A. Yu. Vaichulis, and A. V. Golovin, "The state and trends of animal production in Astrakhan region," *Bulletin of Astrakhan State Technical University. Series: Economy*, №. 1, pp. 92-104, 2018.