ПОДХОД К РАЗРАБОТКЕ ВЕРТИКАЛЬНО-ОРИЕНТИРОВАННОЙ СИСТЕМЫ ПРИНЯТИЯ ИНВЕСТИЦИОННЫХ РЕШЕНИЙ В АГРОПРОМЫШЛЕННОМ КОМПЛЕКСЕ

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Эволюция информационно-цифровых технологий повлекла за собой резкий рост внимания к агропромышленному комплексу. Вложение инвестиций в сельское хозяйство стало выгодным с приходом инновационных технологий и компаний. Сегодня стало возможным автоматизировать максимальное количество сельскохозяйственных процессов за счет создания виртуальной (цифровой) модели всего цикла производства и просчитывать возможную урожайность, себестоимость производства и прибыль. Указанные обстоятельства предопределяют высокую актуальность данной статьи. В качестве объекта исследования в статье определен агропромышленный комплекс российской экономики. Предметом исследования выбрано моделирование трехуровневой вертикально-ориентированной системы принятия инвестиционных решений с целью определения перспективных для вложения средств и производства сельскохозяйственной продукции регионов и культур с высокой урожайностью. Методологической основой исследования стали

AN APPROACH TO THE DEVELOPMENT OF A VERTICALLY-ORIENTED SYSTEM FOR MAKING INVESTMENT DECISIONS IN THE AGRO-INDUSTRIAL COMPLEX

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The evolution of the informational & digital technologies has caused the expansive growth of the attention to the agro-industrial complex. Investments to the agriculture became profitable with the arrival of innovative technologies ad companies. Nowadays it became possible to automatize the maximum of agricultural processes due to the creation of the virtual (digital) model of the whole production cycle and to calculate the possible yield, the production self-cost and the profit. Mentioned circumstances predetermine the high actuality of this article. The object of the article research is the agro-industrial complex of the Russian economics. As a research object was selected the modeling of the three level vertically oriented system for making investment decisions in order to determine funds, prospective for the investment and manufacturing of the agricultural production of regions and cultures with high yield. As methodological basis of the research served portfolio analysis theories and the Profitability-Risk model, developed by authors. As statistic information, necessary for calculations, was used the data of knoema.com site about the crop yield

основные положения теории портфельного анализа и разработанная авторами модель «Доходность-Риск». В качестве необходимой для расчетов статистической информации использовались данные сайта knoema.com. о динамике урожайности сельскохозяйственных культур в разных странах мира за 2010-2017 гг. с интервалом в один год. К основным результатам данного исследования относятся следующие. Видовая и пространственная оптимизация сельскохозяйственных культур, наиболее привлекательных для выращивания с позиций вложения в них инвестиций и формирования оптимального инвестиционного портфеля. Трехуровневая вертикально-ориентированная система принятия инвестиционных решений на федеральном, региональном и местном (до отдельного сельскохозяйственного предприятия) уровнях управления в агропромышленном комплексе российской экономики

dynamics of agricultural crops in different world countries for years 2010-2017 with one year interval. To basic results of this research are referred following ones. The specific and spatial optimization of agricultural crops, most attractive for the growing from positions of investments and formation of the optimal investment portfolio. The three level vertically oriented system for making investment decisions at federal, regional and local (up to a separate agricultural enterprise) management levels in the agro-industrial complex of the Russian economics

Ключевые слова: АГРОПРОМЫШЛЕННЫЙ КОМПЛЕКС, ТЕОРИЯ ПОРТФЕЛЬНОГО АНАЛИЗА, УРОЖАЙНОСТЬ, ИНВЕСТИЦИОННАЯ МОДЕЛЬ «ДОХОДНОСТЬ-РИСК», СИСТЕМА ПРИНЯТИЯ ИНВЕСТИЦИОННЫХ РЕШЕНИЙ

Keywords: AGRO-INDUSTRIAL COMPLEX, PORTFOLIO ANALYSIS THEORY, CROP YIELD, "INVESTMENT-RISK" INVESTMENT MODEL, SYSTEM FOR MAKING INVESTMENT DECISIONS

Introduction

For a long time the agriculture has not been a business, attractive for investors, due to the long production cycle, prone to natural risks and to huge reduction in yields at growing, harvesting and storage, impossibility to automatize biologic processes and the lack of progress in the increase of performance and innovations. The evolution of informational & digital technologies caused the spike of attention to the agro-industrial complex. The development of the agricultural production on the basis of investments became attractive with the arrival of innovative technologies and companies. Due to smart devices, transmitting and processing current dimensions of each object and of its environment (equipment and sensors, measuring soil, plants, microclimate dimensions, characteristics of animals etc.), as well as to modern communication channels between manufacturers of the agricultural production and its external shareholders such companies learned to control the whole cycle

of the manufacturing of plant or animal products. Nowadays it became possible to automatize the maximal number of agricultural processes due to the creation of the virtual (digital) model of the whole production cycle and of mutually related links of the value creating chain, to plan the schedule of works with mathematical exactness, to take urgent measures in order to prevent losses in case of the recorded threat, to calculate the possible crop yield, the production self-cost and the profit. The important place in the development of such processes belongs to the offered and developed by authors the vertically oriented system for making investments decisions in the agro-industrial complex. This system is based on the complex of economic & mathematic models and provides possibilities for making of investment decisions at federal, regional and local (up to a separate agricultural enterprise) levels.

Methods

As the methodological basis of the research became main provisions of the portfolio analysis theory and the Profitability-Risk model, developed by authors. As the statistic information, necessary for calculations, was used the data from knoema.com site about the crop yield dynamics of agricultural crops in different world countries for years 2010-2017 with one year interval.

Results and Discussion

The use of "Profitability-Risk" investment model on the basis "upside-down" principle assumes following activities:

- search and collection of the information on the dynamics of the profitability of agricultural crops, being of interest, global, branch and other indices;

- calculation of basic criteria of profitability, risk and the ratio between the profitability and risk on the basis of the collected information for all selected countries and sectors of economics (according to the statistic data) for all considered investment trends by means of the calculation of the simple

arithmetic mean return and the mean-square deviation as a measure of expected profitability and risk;

- building of the scattering graph, which absciss is the risk and the Y-axis is the expected profitability;

As a result each object of the diagram is characterized by the own profitability and risk level, i.e. has got its coordinates, which we will call the point [1].

- in order to improve features of the formed investment portfolio investors aim to select assets with the lest mutual co-variation, calculated according to the statistic data, what allows the effective diversification of the portfolio;

- selection of securities or other financial instruments, based on the above mentioned criteria and calculations' results.

- the final composition of the subgroup of leaders is formed after the correlation analysis.

Let's illustrate the selection of most preferable trends of the investment in prospective agricultural crops to be included after in the highly diversified investment portfolio on the basis of the dynamics of the crop yield of such cultures. Prospective agricultural cultures comprised: cereal crops in general, corn, wheat, barley and rice, vegetables, sugar beet, citrus cultures, apples, vegetable oil, root crops and bulbs. The data on the dynamics of its crop yield in different world countries for 2010-2017 with the one year were exported from knoema.com site.

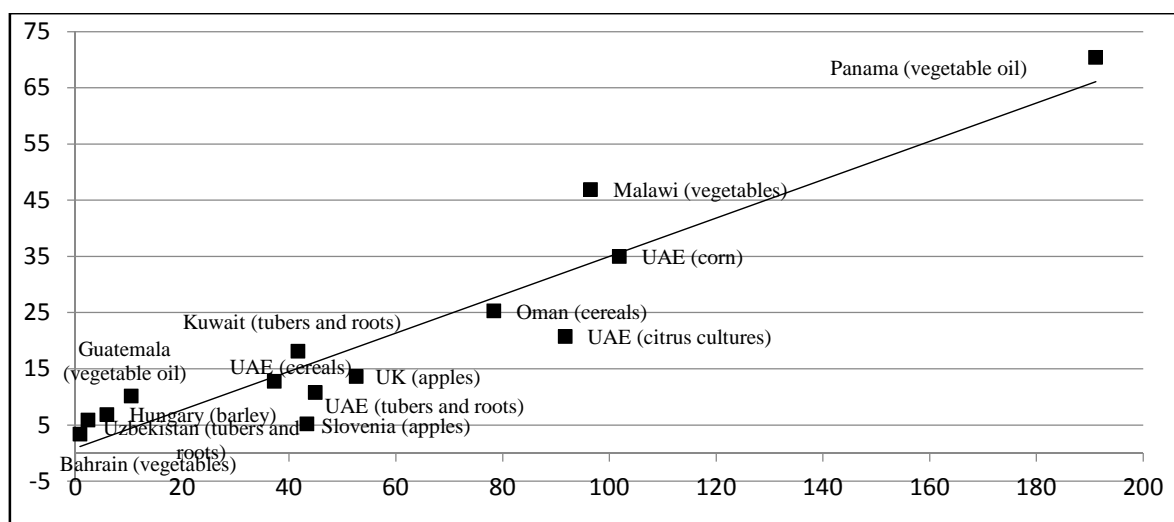At the figure 1 is shown the synthesized group of leading countries.

Fig. 1. Visualization of the results of optimization of investment activities in agriculture at the world level.

It comprises such countries as:

1) Panama, where the main investment object is the vegetable oil production;

This country is of interest for such investors, who prefer the risk.

2) the subgroup of such countries as Malawi, Oman, United Arab Emirates (UAE), where main investment objects are, accordingly, such cultures as: vegetables, cereals, corn and citrus cultures;

This subgroup of countries is of interest for investors with the average attitude to the risk level.

3) the subgroup of such countries as Kuwait and UAE, UAE, Great Britain and Slovenia, where main investment objects are, accordingly, such cultures as: bulbs and root crops, cereals, apples;

This subgroup of countries is also conditionally referred to "mediums", but with less risk level and, accordingly, with less profitability level.

4) the subgroup of such countries as Guatemala, Hungary, Uzbekistan and Bahrein, where to main investment objects are, accordingly, referred such cultures as: vegetable oil, barley, bulbs and root crops, vegetables;

This subgroup of countries, as well as investment objects, can be recommended to investors, not prone to the high risk level.

The unconditional leading country is OAE. This country four times has joined the group of countries, leading in the production of the corn, citrus cultures, bulbs and root crops, cereals.

The distribution of countries, shown at the figure 1 according to the Profitability Risk model, allows to evaluate, what cultures, as investment objects and in what countries of the world mostly correspond to expectations of potential investors.

After the termination of the stage of formation of the group of leaders the investor's task is to form the investment strategy or several strategies, depending on what the group of leaders looks like. The most simple option is the formation of the strategy for the leading country, as the investment portfolio, comprising equally all investment instruments for the production of prospective agricultural cultures. The result of the such approach is that one group comprises instruments with the different level of risk and profitability, so excluding the possibility to take into the account personal preferences of the investor, its financial status, attitude to the risk, age, experience etc. [2].

If in the group of leaders several subgroups can be highlighted, which existence can be explained by means of the financial analysis, then in such a case it will be more acceptable to form several investment strategies in conformity with the number of specified leading subgroups.

The procedure of ranging of investment strategies in the Profitability-Risk model is implemented according to two criteria: Distance and Level. The first criteria reflects the risk amount of the considered investment strategy, and the second one – its relative expected effectiveness as to the trend line. So the second criteria shows in numerical terms how such or such strategy is better (worse) then the "market line".

According to the ranging result the diagram is built, which every point reflects a certain investment object – the agricultural crop. Each point of the diagram is awarded two objective digital nonnegative quantities – the Distance

rank, which is directly pro rata the risk level and the value of the expected profitability of such instrument and the Level rank, allowing to compare the expected profitability of the instrument with the average profitability of groups of instruments, used in leading countries.

The performance of this operation allows to pass the averaged comparative evaluation of the investment preference between considered agricultural crops. In view of this each group of instruments, used in leading countries for the manufacturing of agricultural crops, let's assign two values: the average value of the risk value and the average value of the expected profitability [3] (see fig. 2).
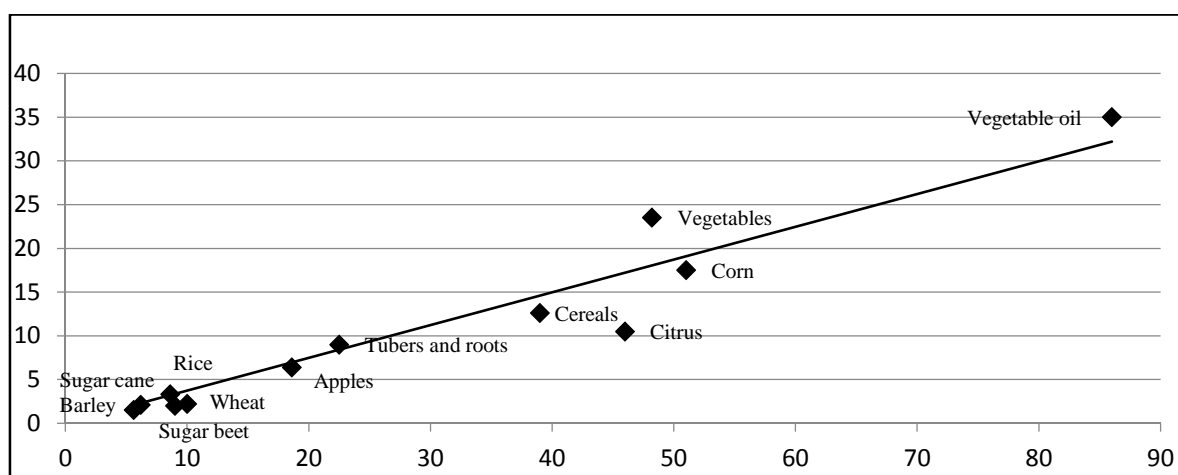

Fig. 2. Visualization of the average species preference agricultural crops at the world level.

According to the data, given on the figure 2, following non-regulatory backgrounds can be formulated:

a) as to the value of the profitability-risk ratio to most attractive can be referred: vegetables, oil, cane and sugar beet;

b) the investment in the vegetable oil, prospecting for investors, who are not avoiding the risk, can be considered as the prospective trend;

c) the investment in the barley, wheat and rice can be considered as prospected trend for investors, avoiding the risk;

d) investment in bulbs, root crops and apples can also be considered attractive risk avoiding investors, though relevant ratios between the profitability and risk for this subgroup have got higher values in comparison with the previous subgroup.

From results of the spatial and specific differentiation of the efficiency of the growing of agricultural crops at the world level let's pass to the building of the three level vertical-oriented system for making of investment decisions for the development of the agro-industrial complex of the Russian economics.

First of all let's synthetize with the Profitability-Risk model the group of culture leaders by the statistic data on its crop yield for the period of 2013 - 2018 [4, 5, 6, 7].

For the *federal level* was determined the following group of leading cultures: cucurbits, vegetables for the dry forage, oilseeds, general wheat, summer wheat and spring rape [8]. Anyway, this group proved to be non-homogenous: cucurbits were significantly standing apart. Provided this circumstance, as well as the fact, that in the Russian Federation, there is a very minor part of the territory, which complex of weather conditions meets necessary requirements for the growing of cucurbits, authors have found it possible and necessary to build the Profitability-Risk model without such a culture (see fig.3).
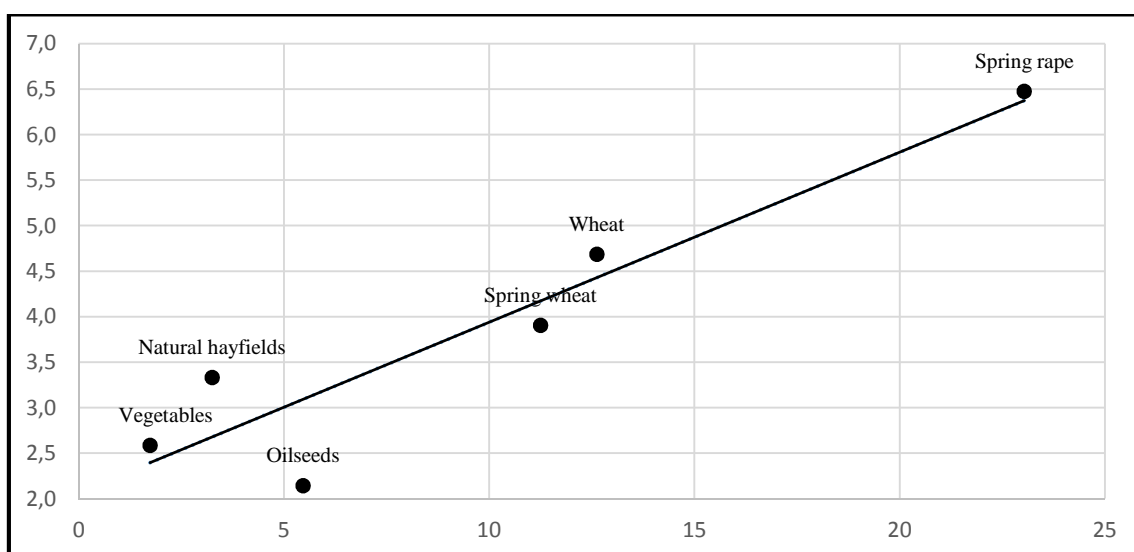
Fig. 3. Visualization of the leading cultures according

to the "Profitability-risk" model (generalized analysis).

Basing on evaluations of expected risks (see fig.3), for investors, not prone to the risk, also following investment trends can be recommended: vegetables (with the expected profitability of 3,3% and risk of 3,3%), hay (natural haylands) (3,3% and 3,3%) oilseeds (2,1% and 5,5%). For investors, preferring the risk, the spring rape can be the attractive trend for investment (6,5% and 23,0%). The wheat (4,7% and 12,6%) and the spring wheat (3,9% and 11,3%) can be recommended as trends for the investment for investors with the neutral attitude to risk.

At the *regional level* was performed the sequential analysis of the profitability and of the investment risk by the data of the national statistics [4, 5, 6, 7]. Regions, being outsiders according to the adopted criteria, have been excluded from the consideration. As a result was obtained the following diagram for cereals and grain legume crops (see fig.4).
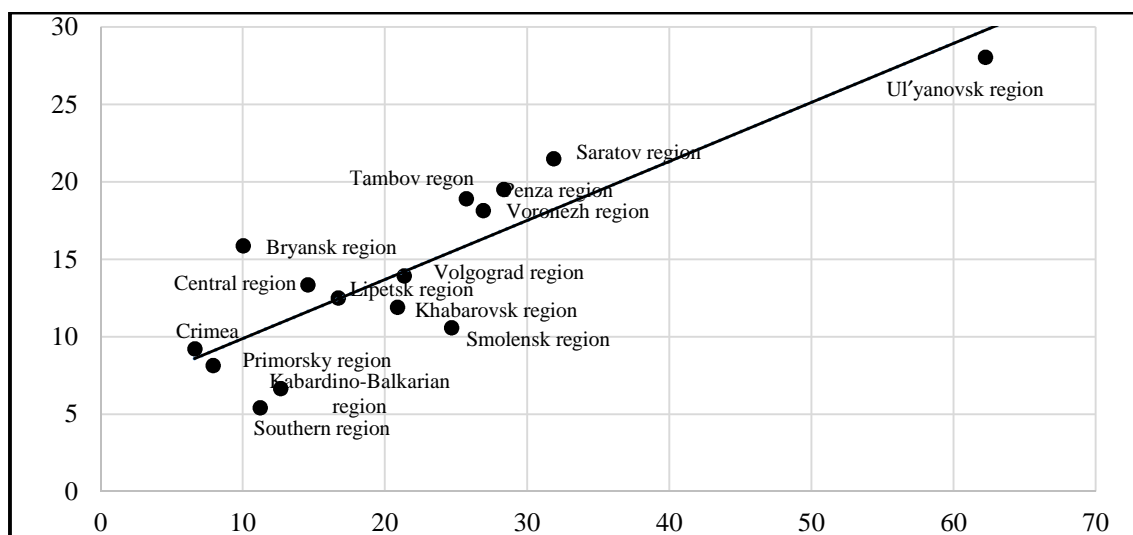

Fig. 4. Leading regions in grain and leguminous crops.

The analysis, performed by cereals and leguminous crops, has demonstrates the following:

– for investors, prone to the risk, Ul′yanovsk region becomes more attractive;

– conditionally can be separated two subgroups of regions with the average profitability-risk ratio:

1) Saratov, Penza, Tambov and Voronezh regions (risk in the interval of 26% - 32 %).

2) Bryansk, Volgograd, Lipetsk, Smolensk regions, Khabarovsk region and the Central federal district in general (the risk in the interval is 10% - 25%).

– other regions (Crimea, Southern federal district, Primorsky region and Kabardino-Balkaria) are of priority for investors, avoiding the risk. With that Bryansk regions should be highlighted as to the value of the profitability-risk ratio (the profitability-risk ratio is 1,58).

Level rank) the "homogeneity" pattern inside subgroups is conditional. Therefore, the third group (the subgroup for investors, avoiding the risk) is relatively homogenous by the Risk rank, as the distance of these cultures from the beginning of coordinates can be conditionally taken as equal one. Though as to the Rank level the range of values is large enough and witnesses that provided the absence of considerable future material changes, the future selection of the investment object (for example, Crimea or Southern federal district) looks rather obvious in favor of Crimea.

The second subgroup is more heterogeneous (as to considered ranking criteria), as there is a large scatter for each of considered criteria.

The investor with neutral attitude to risk can be interested in the trend, offering to invest funds in the wheat growing (see see fig.3) and, so, determine the selection of the agricultural crop (specific optimization). Then regional results (see fig.4) will show what certain region or group of regions is better for investors with the neutral attitude to risk (spatial optimization). World level results (see fig.1 and 2) witness that the wheat growing fully corresponds with investor's perception with neutral attitude to the risk.

The offered three level vertically oriented system for making investment decisions can be used for the optimal distribution of funds from the federal

budget in order to obtain the maximal yield from the growing of cereal and pulse crops with acceptable values of the allowable risk.

The ratio between the profitability and the risk at both world and federal level is almost equal and is 0,33, what shows, that the agriculture level in Russia, , while ceding in absolute values, almost does not cede to best global indices as to "efficiency". Obtained results can also be analyzed in reverse order: initially we select a federal entity and then in what culture (or a group of cultures) funds should be invested.

Conclusion

The performed specific and spatial optimization allowed to reveal in what world countries and what specific agricultural cultures are most attractive for the growing from the position of investments and formation of the optimal investment portfolio.

Relating to the development of informational technologies in the agro-industrial complex of the Russian Federation was offered the three level vertically-orientated system for the making of investment decisions at federal, regional and local (up to a certain agricultural enterprise) management levels.

The developed three level vertically-oriented system for the making of investment decisions can be used for the optimal distribution of federal budget funds in order to obtain the maximal yield from the growing of cereal and pulse crops with acceptable values of the allowed risk.

Список литературы
1. Герцекович Д.А., Горбачевская Л.И., Подлиняев О.Л., Астафьева Е.М. Инвестирование в сельское хозяйство российской федерации: пространственная и видовая оптимизация // Инновационные технологии как инструмент развития и модернизации экономики: сб. статей Международной научно-практической конференции (1 июля 2019 г., г. Челябинск). Уфа: Аэтерна, 2019. С. 23-32.
2. Гибсон Р. Формирование инвестиционного портфеля: Управление финансовыми рисками. Пер. с англ. 3-е изд., испр. – М.: Альпина Паблишер, 2015. – 274 с.
3. Герцекович Д.А., Горбачевская Е.Ю., Подлиняев О.Л., Ларин С.Н., Константинова Т.Д. Моделирование стратегических инвестиционных решений

производителей сельскохозяйственной продукции: пространственная и видовая оптимизация // Экономика и предпринимательство, 2020. Вып.14. № 9(122). С. 642-647.

4. Инвестиции в России. 2017: Стат. сб. – М.: Росстат, 2017. – 189 с.

5. Россия в цифрах. 2018: Крат. стат. сб. – М.: Росстат, 2018. – 522 с.

6. Российский статистический ежегодник. 2018: Стат. сб. – М.: Росстат, 2018. – 694 с.

7. Сельское хозяйство в России. 2019: Стат. сб. – М.: Росстат, 2019. – 91 с.

8. Герцекович Д.А., Горбачевская Л.И., Подлиняев О.Л., Макеева А.И. Теория портфеля как инструмент формирования инвестиционных решений в сельском хозяйстве // Инновационные технологии как инструмент развития и модернизации экономики: сб. статей Международной научно-практической конференции (1 июля 2019 г., г. Челябинск). Уфа: Аэтерна, 2019. С. 32-42.

References

1. Gercekovich D.A., Gorbachevskaya L.I., Podlinyaev O.L., Astaf'eva E.M. Investirovanie v sel'skoe hozyajstvo rossijskoj federacii: prostranstvennaya i vidovaya optimizaciya // Innovacionnye tekhnologii kak instrument razvitiya i modernizacii ekonomiki: sb. statej Mezhdunarodnoj nauchno-prakticheskoj konferencii (1 iyulya 2019 g., g. CHelyabinsk). Ufa: Aeterna, 2019. P. 23-32.

2. Gibson R. Formirovanie investicionnogo portfelya: Upravlenie finansovymi riskami. Per. s angl. 3-e izd., ispr. – M.: Al'pina Pablisher, 2015. – 274 p.

3. Gercekovich D.A., Gorbachevskaya E.YU., Podlinyaev O.L., Larin S.N., Konstantinova T.D. Modelirovanie strategicheskih investicionnyh reshenij proizvoditelej sel'skohozyajstvennoj produkcii: prostranstvennaya i vidovaya optimizaciya // Ekonomika i predprinimatel'stvo, 2020. Vyp.14. № 9(122). P. 642-647.

4. Investicii v Rossii. 2017: Stat. sb. – M.: Rosstat, 2017. – 189 p.

5. Rossiya v cifrah. 2018: Krat. stat. sb. – M.: Rosstat, 2018. – 522 p.

6. Rossijskij statisticheskij ezhegodnik. 2018: Stat. sb. – M.: Rosstat, 2018. – 694 p.

7. Sel'skoe hozyajstvo v Rossii. 2019: Stat. sb. – M.: Rosstat, 2019. – 91 p.

8. Gercekovich D.A., Gorbachevskaya L.I., Podlinyaev O.L., Makeeva A.I. Teoriya portfelya kak instrument formirovaniya investicionnyh reshenij v sel'skom hozyajstve // Innovacionnye tekhnologii kak instrument razvitiya i modernizacii ekonomiki: sb. statej Mezhdunarodnoj nauchno-prakticheskoj konferencii (1 iyulya 2019 g., g. CHelyabinsk). Ufa: Aeterna, 2019. P. 32-42.