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Oliva Liudmila, Heijman Wim, Turyansky Alexander**MANURE PROBLEM IN AGRICULTURE
OF BELGOROD REGION, RUSSIA**

Belgorod Region is one of the most agrarian regions of Russia, where fundamental role belongs to ecologization of the agricultural production. There are a lot of livestock enterprises and farms. That is why the manure problem is very important. There is the problem connected not only with the organisation of manure gathering, but also manure transportation in those districts of Belgorod region where their shortage is observed.

It is necessary not to forget that the use of organic fertilizers should be ecologically and economically expedient.

The aim of our study is to find the shortest way of manure transportation with minimum cost.

Key words: organic fertilizer, manure, minimal cost, GAMS, Belgorod region.

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Literature review

The problem of economic management and protection of land is timely not only for individual countries, but also for the entire world community, which makes this problem a global one. According to the legislation of Russia Federation, the possession, use, disposal of land and other natural resources are jointly administered by the Russian Federation and its subjects. That is why in addition to national, regional level of economic protection of agricultural land should be provided (Bryzhko, 2003).

Consequently, it is necessary to classify the event of economic protection of agricultural land in the following levels (Bryzhko, 2004):

- global, which represents a significant problem worldwide for all countries in the world;
- national, which solves the problem of protection of agricultural land by economic means within a single state – the Russian Federation;
- regional, which reflects the particular qualities of measures for economic protection of land in certain regions of the Russian Federation;
- municipal, which reflects the importance of the problem for the individual administrative-territorial formations (districts).

Therefore in modern society the problem of making agriculture in our word ecological is very important.

Ecologization is a process of consistent introduction of ideas of nature conservation and environmental sustainability in the field of legislation, administration, development, technology, economics, education, etc. This process includes not only

the introduction of resource-saving technologies, water treatment systems, the principle of “polluter pays”, but above all, knowing about the end of our planet and ecological space followed by environmental disaster and question of human existence (Zakharova, 2007).

Even in the 60-70 years various forms of alternative agriculture (organic, ecological, biodynamic, and biological) started to develop. This form suggest a complete or almost complete abandonment of industrial fertilizers and chemicals (Kiryushin, 1996).

In most Western countries, alternative agriculture names of “the survival of agriculture.” In 1972 in France the International Federation of Organic Agriculture Movements (IFOAM) was established. The main objectives of this organization are: to preserve and improve soil fertility, environmental protection, energy saving irreplaceable resources, improvement of product quality, high quality production, as well as ensuring the sustainability of agro ecosystems (Chernikov, 2000).

Unfortunately, today in the world there is no uniform international standards for organic production. Organic certification of agricultural products is carried out according to the country of an organic market.

The basic idea used in organic farming is the idea of a closed cycle in the economy, which represents an environmental and economic principles. For example, an organic fertilizer taken from animal husbandry must be the basis for maintaining soil fertility and to provide plant nutrients (Lysenko, 2008).

In the conditions of a large concentration of livestock there is a problem how to use manure. So in one way it can be used as organic fertilizer (Ceotto, 2005; Dietz and Hoodervorst, 1991). But in the other hand, the livestock wastes are considered to be also as a potential source of contamination of soil, surface water and groundwater, air and as a result to do damage to human health (Jongbloed and Lenis, 1998; Van den Brandt and Smit, 1998; Oenema, 2004).

Therefore in modern world the major role is given to environmental protection policy. The main policy instrument to control manure use is financial instrument, such as subsidies for effective manure use and also taxes and penalty for environmental damage (Frank, 1991; Araj, 2004).

There are two main factors of manure use. The first factor is the nutrient content of manure and the other one is manure transportation (Ronald, 2012). These two factors are directly connected. The manure demand depends from the nutrient concentration of manure and soil productivity. Than the question about manure transportation comes by itself (Paudel, 2009; Eli, 2004).

Introduction

The ecological and sustainable agriculture provides accumulation of the vegetative rests (i.e. organic substance) in the form of straw, manure, green manure on a soil surface. It will promote liquidation of erosive processes, the best physical condition of soils and water balance. In due course it will reduce the contamination of fields weed vegetation, lower disease of agricultural crops, also change number of harmful insects and lead to reduction of power inputs.

Change of system of relations of production in agriculture of the Belgorod region provides changes in systems of farming which cannot be uniform any more. They assume variety of technological elements, narrow specializations as the structure of areas under crops which in certain degree forms agriculture systems is defined now not by the control system instruction but by the market, economy specialization, presence and animal industries level.

New systems of agriculture should consider the present condition of economy of all kinds of the property, to be more flexible, multiple, considering not only soil-climatic, economic, but also social conditions of managing.

The decision of the ripened problem in sphere of agriculture of the Belgorod region demands effective mechanisms and methods.

But it is necessary to remember that application of all kinds of fertilizers should be carried out on a scientific basis,

taking into account biological features of cultural plants, environmental conditions, fertility of soil and other actions.

Preservation of soil fertility is a problem which demands the complex decision. Therefore, planning agrochemical actions, agricultural commodity producers should understand that it is necessary for soil to return all nutrients after reception of agricultural crops.

Belgorod Region

Belgorod Region is one of the most agrarian regions of Russia.

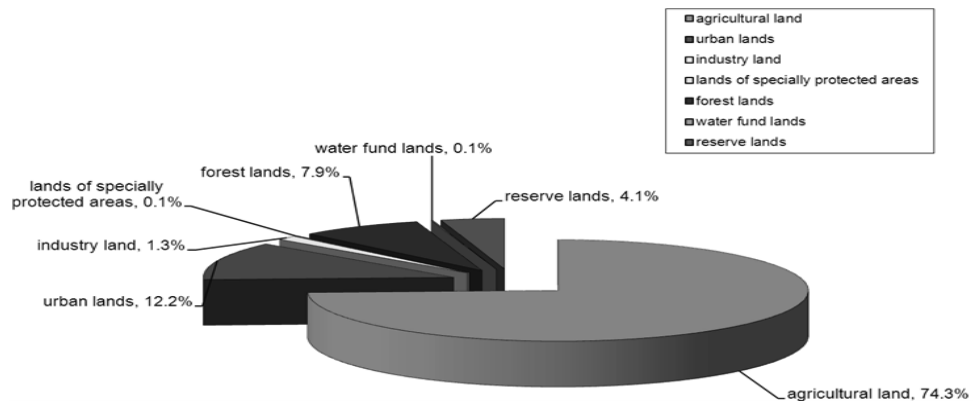
The land fund of Belgorod region on the 1st of January 2011 is equal to 2713.4 thousand hectares (fig. 1) [1].

The most part of the agricultural land belongs to the farmland and exist 1831.3 thousand hectare (90.8%), the woodland which are not entering into wood fund exist 67.9 thousand hectare (3.3%). The part of the land occupied with water objects, including bogs, exists 33.3 thousand hectare (1.7%), roads – 17.4 thousand hectare (0.9%), constructions – 10.4 thousand hectare (0.5%), the disturbed land – 0.3 thousand hectare (0.1%), the other land – 34.7 thousand hectare (1.7%).

In the farm land structure a field occupies 1651.9 thousand hectare (77.1%). Natural meadowlands – hayfields occupy 55.7 thousand hectare (2.6%), grassland (pastures) – 399.6 thousand hectare (18.7%). 74.3% of these lands are situated on the territory belongs to the agricultural land. Longstanding plantations make 34.1 thousand hectare (2.6%). 68.9% from longstanding plantations are situated on the agricultural land.

For the last five years the total area of users of these lands has decreased for 73.1 thousand in hectare. The reason is withdrawal of the land of the general joint property in a fund of the land redistribution and the termination of industrial activity of many agricultural enterprises.

In Belgorod region fundamental role belongs to ecologization of the agricultural production. So, the growth of organic waste from animal husbandry enterprises and farms is expected, and as a result there will be an additional soil loading. Manure utilization should be economically reasonable and safe for ecosystems.



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Figure 1. The structure of land found of Belgorod Region on the 1st of January 2011

The basic infringements at entering of organic fertilizers are connected with overdose which can lead to accumulation of mineral nitrogen in the soil and plants in superfluous quantities. The regular overdose at entering of pig-breeding drains in the long term can lead to the salinification of soils, especially in east districts of Belgorod region, and to the water pollution. At untimely seal of pig-breeding drains into the soil a considerable quantity of ammonia and other gaseous products are vaped and it became the cause of fair discontent of countrymen.

To avoid these problems it is necessary to adhere strictly to the developed regulations of organic fertilizers use. According to this rules agrochemical service analyses all organic fertilizers before their entering into the soil and is rated entering doses, taking into account fertility of a concrete tract of land and requirements of an agricultural crop (table 1).

Table 1 – The maintenance of organic substance, nitrogen, phosphorus and potassium in various organic fertilizers, kg/t

Kind of organic fertilizers	Moisture, %	Organic substance	N	Limits of the maintenance of nitrogen	P2O5	K2O
Manure drains	97.5	17.7	2.8	0.8-5.5	1.5	1.7
Chicken manure	37.0	520	24.4	6.3-43	21.4	22.2
Cattle manure	77.3	200	8.1	3.9-16.7	2.3	5.0

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The given regulations are expedient for confirming in region governmental order, and for their nonfulfillment it is advisably to establish administrative responsibility. The control for execution of these regulations is assigned to the protection soils department. Most effective control for entering of organic fertilizers is possible with use of the satellite navigation system.

The legislation of the Russian Federation is not clearly defined regulatory goals in a number of hectares for livestock enterprises of the complex. It is estimated that on the average in Belgorod region on 1 hectare of the farm field is 0.9 livestock units, which corresponds to world standards.

In order to develop biodynamic farming in the region, promote the interest of agricultural producers in the use of liquid manure (pigwaste), the Government of Belgorod region agreed to establish a grant from the regional budget to agricultural organizations and peasant farmers in the liquid organic fertilizer (pig effluent) used in agriculture area, the rate of 60 rubles (over 1.6 euro) per cubic meter, introduced into the soil. If the amount of organic fertilizer application rate does not correspond to calculated taking into account soil fertility, organic fertilizer subsidy made in this field will not be paid. Subsidies paid during the reporting month for work performed under the act confirming the application of organic fertilizers in accordance with the above requirements.

There is the problem connected not only with the organization of manure gathering, but also manure

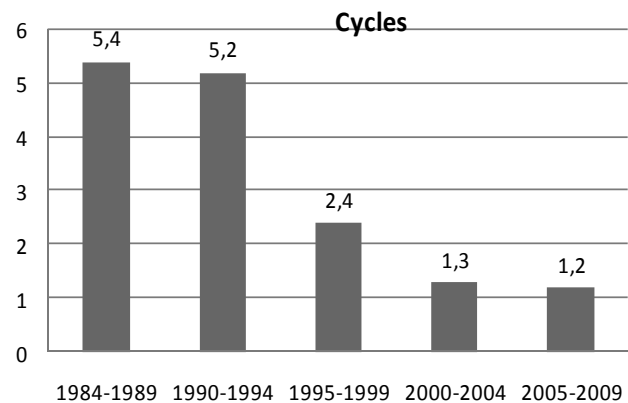
transportation in those districts of Belgorod region where their shortage is observed. It is necessary not to forget that the use of organic fertilizers should be ecologically and economically expedient.

Scientists and whole world practice recognized for a long time that without use of organic fertilizers economically expedient conducting agricultural production simply isn't possible. Entering of organic fertilizers under crops in the agricultural organizations of the Belgorod region is presented in table 2 and figure 2.

Table 2 – Entering of organic fertilizers under crops in the agricultural organizations of Belgorod region

Factor	Years					2010 to 2006, %
	2006	2007	2008	2009	2010	
Entering of organic fertilizers: All, thousand tons	926.6	911.8	1297.8	1663	1550.1	623.5
On one hectare of crops, tons	0.9	0.9	1.2	1.5	1.4	0.5
including on crops: cereals (without maize)	1.1	1.1	1.3	1.2	1.1	0
white beet (factory)	3.1	2.9	2.4	3.8	3.1	0
sunflower	0.2	-	0.1	-	0.4	0.2
vegetables	-	-	0.3	-	-	-
feed crops	0.2	0.4	0.7	0.8	1.7	1.5

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Figure 2. Dynamics of organic fertilizers (manure) in the Belgorod region, thousand tons

As practice confirms it is necessary to support the optimum maintenance of humus in soil, because if there is the humus decrease the soil fertility and productivity of agricultural crops decrease too.

Many agricultural manufacturers try to compensate a lack of humus in the soil by means of increase of mineral fertilizers. But it doesn't bring success. It is accompanied by negative consequences. The majority of mineral fertilizers are characterized by physiological acidity. In a consequence of that their entering into soil the excessive quantity of mineral fertilizers can be a reason of development of soil acidifying.

Last decades in the farms of Belgorod region the chemically-technologic intensive system of agriculture received wide expansion. It helped to reach some successes in agricultural production and increase productivity of agricultural crops. All it has been reached at the expense of introduction alternative technology, use of high-efficiency techniques, high-yielding grades and hybrids.

At the same time these indicators are accompanied by the big expenses of work, energy, finances. Energy charge is increase on unit of a gain of agricultural production. Addition capital investments pay off with smaller efficiency. As a result of the industrial approach to agriculture and wide introduction of high cost intensive systems of agriculture the agro biological principle of wildlife management as the major factor of energy and resource saving is lost.

The problem of rational use, protection and improvement of soil resources, especially in favorable for development of agriculture regions what the area concerns, is a problem of vital importance for present and in particular for future generation of people.

Process of dehumification arable horizon has amplified last decade in connection with infringement of crop rotations, share increase cultivated crops, shortfall of organic into soils.

According to inspection, changes of the maintenance and stocks of humus in arable horizons of all types of soils are revealed. On various types of soils there were sharp losses of humus and as a whole is lost more than 10 million tons humus.

For last 20 years entering of organic fertilizers cut down from 8 million tons to 3.6 million in 2010 year. The areas under long-term grasses were also reduced.

Apparently from the above-stated, after the centuries-old constant deterioration of fundamental soil resources expressed in loss of fertility, it is necessary to pass in plant growing production to biological system of agriculture as the major technological innovation.

Indicators

To describe the nowadays situation in agriculture of Belgorod region and make an evaluation of manure transportation we used the data of State Statistic Committee of Belgorod region on the following indicators:

- manure supply and demand in districts of the Belgorod region;
- distance between the districts;
- cost of transporting 1 tone of manure per 1 km.

Data and method

In addition, to achieve effective and efficient waste management of livestock enterprises, the

plan for dealing with nutrients and organic wastes is required.

The regulatory document must identify:

- crop which will be made manure;
- applying norms of manure;
- measures to prevent spills and odour problems.

Taking this into account and analysis of scientific literature to develop the plan for the management of nutrients and organic wastes we need to conduct following measures:

- to study manure for the content and amount of nutrients;
- to analyse the soil under the proposed plantings in order to determine the need for soil nutrients. The basic test is to determine the content of phosphorus, potassium, and magnesium oxide, as well as the pH of the soil on an area of 10 hectares each;
- to estimate the residual nitrogen from the previous dressing of crops;
- to define the methods and timing of manure applying. When choosing a method of manure application (direct watering, irrigation, bunker machine) it should be taken into account the following factors: the type of manure, the available funds, and the amount contributed by the manure, soil density, the area for manure applying;
- to define areas for manure applying and rates. Manure should be applied to the fields with the lowest nutrient content. In this case, the absorption of nutrients is faster and the risk of environmental pollution is reduced. Factors that should be taken into account when determining the applying rates of manure include the absorptive capacity of the soil and the need for nitrogen, potassium, carbon and phosphorus. Rotation of crops can maintain a balance of nutrients in the soil and crops to ensure receipt of the appropriate number of nutrients;
- to determine the type of fertilizer that should be made in addition to manure. In some cases, you should consider the possibility of making a fertilizer to the manure. This provides flexibility in manure in the spring weather;
- to carry out inspection facilities and equipment necessary to manure, so that the crops had been made under the allotted amount of nutrients. In assessing the existing facilities should take into account the volume of manure with different densities (liquid and solid fractions of manure) and the corresponding need for transport;
- to use all manure produced on livestock sector;
- to take into account factors such as soil erosion, surface runoff to prevent pollution of surface and groundwater. In addition to the traditional methods of preservation of the environment the distance from the site of manure to water bodies should be taken into account. As a rule, is not recommended to

apply the liquid fraction of manure into the soil at a distance of less than 10 meters, and the solid fraction – less than 5 meters from water bodies.

The leaders of agricultural enterprises should implement production control and monitoring of soil and environmental conditions in accordance with the applicable environmental and health legislation. The annual maximum application rate of nitrogen in the soil with manure runoff by 1 ha of crop rotation shall not exceed 200 kg.

The use of organic fertilizers (manure) must be environmentally and economically feasible. It is therefore necessary to calculate the turnover of organic fertilizers, depending on production and needs of districts of Belgorod region. We have solved the problem of optimal plan of transportation of organic fertilizers from livestock activities between the districts of the region using GAMS program.

This program solves the problem of "optimization of transportation," which is a linear programming problem. Thus, it is important to answer the economic question: what is the amount of organic fertilizer, how and for what districts transport it to minimize the cost?

To solve this problem we need to know manure supply and demand in districts (table 3) and the distance between the districts of Belgorod region (Table 4).

The average cost of transporting 1 tone of manure per 1 km is 0.063 rubles.

Table 3 – The organic fertilizers in 2011 year

Districts of Belgorod region	Expected quantity of manure in 2011, thousand tons SUPPLY	Necessary quantity of manure in 2011, thousand tons DEMAND
Belgorodsky	545.1	895.2
Starooskolsky	431	289.2
Alekseevsky	693	754.8
Borisovsky	278	141.6
Valuyksky	193.6	392.4
Veydelevsky	179.6	159.6
Volokonovsky	475	621.6
Grayvoronsky	297.3	114
Gubkinsky	402.2	151.2
Ivnyansky	595	178.8
Korochansky	570	464.4
Krasnoyarusky	271.3	474
Krasnogvardey	528	159.6
Krasnensky	44	69.6
Novooskolsky	291.9	1142.4
Prohorovsky	605	181.2
Rakitnsky	595	537.6
Rovensky	379	159.6
Chernyansky	310	93.6
Shebekinsky	948.4	1695.6
Yakovlevsky	496	268.8
All	9128.4	8313.6

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Table 4 – The average distance between districts of Belgorod region, km.

	Belgorodsky	Starooskolsky	Alekseevsky	Borisovsky	Valujksky	Vejdelevsky	Volokonovsky	Grayvoronsky	Gubkinsky	Ivnyansky	Korochansky	Krasnoyarusky	Krasnogvardey	Krasnensky	Novooskolsky	Prohorovsky	Rakitnsky	Rovensky	Chernyansky	Shebekinsky	Yakovlevsky
Belgorodsky	42	180	200	70	160	195	130	82	144	83	80	90	160	198	134	84	74	253	145	66	52
Starooskolsky	180	40	140	214	159	172	118	250	70	176	112	246	178	168	74	118	200	195	42	138	164
Alekseevsky	200	140	30	260	90	64	90	280	168	258	155	268	40	62	88	110	259	70	98	160	202
Borisovsky	70	214	260	30	200	240	170	34	146	64	103	60	226	240	182	95	40	286	178	108	82
Valujksky	160	159	90	200	35	50	44	200	162	210	130	246	70	120	84	168	220	86	110	108	178
Vejdelevsky	195	172	64	240	50	30	76	246	196	262	176	280	90	122	80	226	263	41	142	152	224
Volokonovsky	130	118	90	170	44	76	30	189	118	178	90	214	50	96	44	130	186	109	79	70	154
Grayvoronsky	82	250	280	34	200	246	189	20	188	88	144	46	236	271	216	131	58	317	223	138	84
Gubkinsky	144	70	168	146	162	196	118	188	38	110	64	173	134	116	86	56	144	221	62	116	100
Ivnyansky	73	176	258	64	210	262	178	88	110	20	85	60	220	228	176	56	33	308	158	130	34
Korochansky	80	112	155	103	130	176	90	144	64	85	33	150	125	122	80	82	116	202	78	79	64
Krasnoyarusky	90	243	268	60	246	280	214	46	173	60	150	20	226	283	224	122	36	330	225	156	84
Krasnogvardey	160	178	40	226	70	90	50	236	134	220	125	226	35	60	52	168	240	88	74	118	80
Krasnensky	198	168	62	240	120	122	96	271	116	228	122	283	60	22	50	162	248	130	56	138	188
Novooskolsky	134	74	88	182	84	80	44	216	86	176	80	224	52	50	30	116	192	132	34	84	142
Prohorovsky	84	118	110	95	168	226	130	131	56	56	82	122	168	162	116	27	86	244	100	78	37
Rakitnsky	74	200	259	40	220	263	186	58	144	33	116	36	240	248	192	86	20	306	190	127	48
Rovensky	253	195	70	286	86	41	109	317	221	308	202	330	88	130	132	244	306	28	160	186	258
Chernyansky	145	42	98	178	110	142	79	223	62	158	78	225	74	56	34	100	190	160	31	98	140
Shebekinsky	66	138	160	108	108	152	70	138	116	130	79	156	118	138	84	78	127	186	98	35	78
Yakovlevsky	52	164	202	82	178	224	154	84	100	34	64	84	80	188	142	37	48	258	140	78	33

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The results of manure transportation

Scientists around the world recognized that without the use of organic fertilizers cost-effectiveness of agricultural production is impossible. We carried out the analysis of physic and chemical parameters of manure as organic fertilizer for the farmland of Belgorod region. In terms of concentration of farm animals in a limited area, liquid manure can be a potential source of land damage. Therefore, we studied 50 samples of liquid pig manure taken from specialized pig farms such as JSC “Kryukovsky pig farm”, LLC “Strigunovsky pig farm”, LLC “Nikitovsky pig farm”, LLC “Kolomytsevsky pig farm” in testing laboratory of Belgorod State Agricultural Academy. The results showed that manure in terms of quality and safety correspond the requirements of “Veterinary-sanitary regulations on the use of livestock wastewater for irrigation and fertilization of grassland,” and can be used as organic fertilizers, without prejudice to the environment.

Application of fertilizers is an important condition for improving crop yields and characterized by high economic efficiency. We know that through the use of manure there are ¾ crop growth.

But there is the problem of manure transportation. The proposed model of manure transportation is intended to address the problem of minimizing the cost of transportation of organic fertilizers to meet the essential needs of areas, given the available amount of organic fertilizer (table 5, figure 3).

Analyzing received data from table 5 we can make the following conclusions. For the Belgorod region is necessary to transport 138.2 thousand

tons from Borisovskiy and 496 thousand tons from Yakovlevskiy districts. For needs satisfaction of the Alekseevskiy district it should be transported 21.2 thousand tons of manure from Krasnoyarskiy and 40.6 thousand tons from Rovenskiy district; of Borisovskiy – 1.8 thousand tons from Graivoronskiy district. For Valuiskiy district it should be transported 179.6 thousand tons from Veidelevskiy and 19.2 thousand tons from Rovenskiy regions. It is need to transport 146.6 thousand tons of manure from Krasnogvardeiskiy to Volokonovskiy district. To satisfy the needs of organic fertilizers in Krasnoyarskiy district the transportation of 145.3 thousand tons from Volokonovskiy district and 57.4 thousand tons from Rakitskiy district is required. For Krasnenskiy district it is necessary to transport 25.6 thousand tons from Krasnogvardeiskiy district, for Novooskolskiy – 48.2 thousand tons from Starooskolskiy, 251 thousand tons from Gubkiskiy, 66.3 thousand tons from Korochanskiy, 175 thousand tons from Krasnogvardeiskiy and 310 thousand tons from Shebekinskiy district.

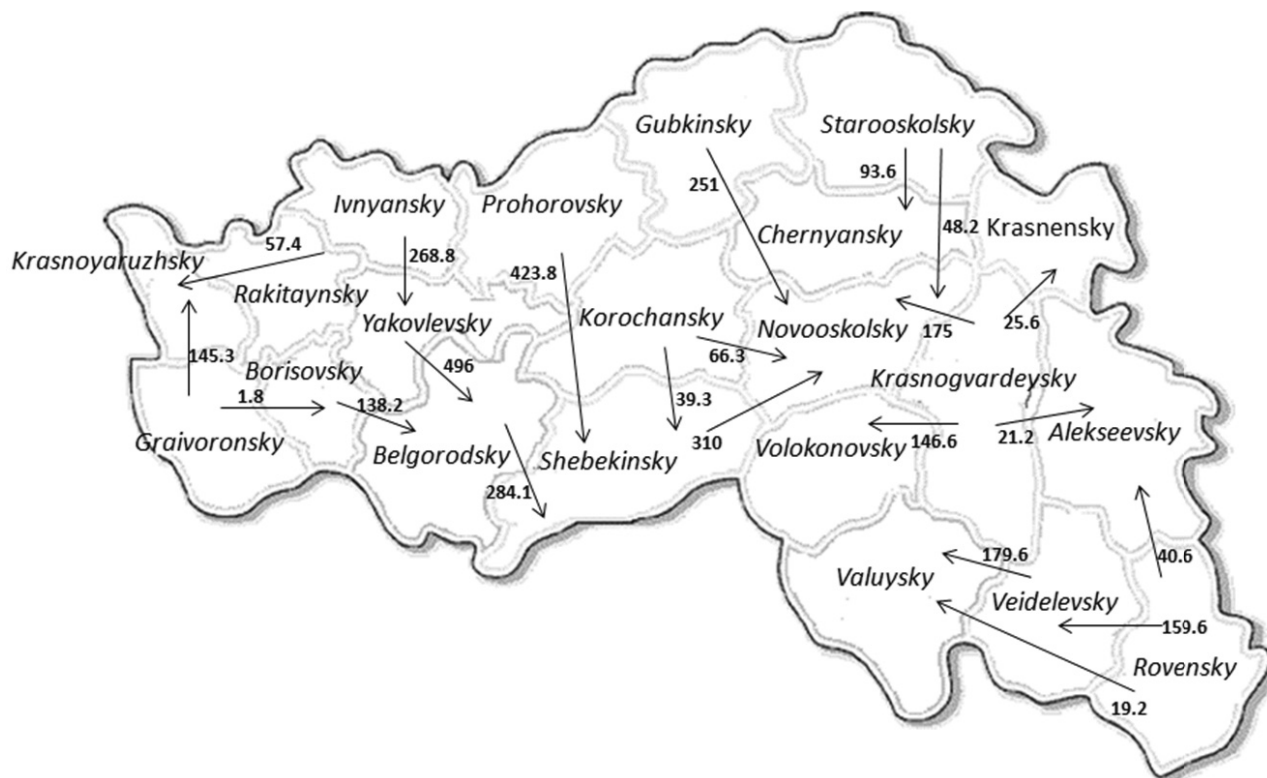
To satisfy demand in Chernyanskiy district it is necessary to transport 93.6 thousand tons of manure from Starooskolskiy district. For needs satisfaction of Shebekinskiy district it is necessary is transport 284.1 thousand tons from Belgorod region, 39.3 thousand tons from Korochanskiy, 423.8 thousand tons from Prohorovskiy district. It is need to transport 268.8 thousand tons of manure from Ivnyanskiy district to Yakovlevskiy district.

Our calculations showed that the total cost of transportation will be equal 23.2 million rubles (0.6 million euro).

Table 5 – Optimal model of manure transportation in Belgorod region, thousand tones

	Belgorodsky	Starooskolsky	Alekseevsky	Borisovsky	Valujksky	Vejdelevsky	Volokonovsky	Grayvoronsky	Gubkinsky	Ivnyansky	Korochansky	Krasnoyarskiy	Krasnogvardeisky	Krasnensky	Novooskolsky	Prohorovsky	Rakitsky	Rovensky	Chernyansky	Shebekinsky	Yakovlevsky
Belgorodsky	261.8																				284.1
Starooskolsky		289.2													48.2					93.6	
Alekseevsky			693																		
Borisovsky	138.2			139.8																	
Valujksky					193.6																
Vejdelevsky					179.6																
Volokonovsky							475														
Grayvoronsky				1.8				150.2				145.3									
Gubkinsky									151.2						251						
Ivnyansky										326.2											268.8
Korochansky											464.4				66.3						39.3
Krasnoyarskiy												271.3									
Krasnogvardeisky			21.2				146.6						159.6	25.6	175						
Krasnensky													44								
Novooskolsky															291.9						
Prohorovsky																181.2					423.8
Rakitsky												57.4						537.6			
Rovensky			40.6		19.2	159.6													159.6		
Chernyansky																					
Shebekinsky																					948.4
Yakovlevsky	496														310						

Sours: own calculations



Sours: own calculations

Figure 3 – Manure transportation in Belgorod region, thousand tons

Conclusion.

One of the agricultural problems in Belgorod region is manure problem, because in some districts of region its less and in other it is more manure. So the decision is to transport from on district to another with minimum cost.

The results of our research shows that we need 28.2 million rubles to transport 8 313.6 thousand tons of manure.

We offer the following recommendations for the use of manure:

1. To take into account the problem of manure transportation and to find the shortest way and minimal cost according to manure supply and demand in different districts in region.
2. Be sure to carry out calculations of livestock at livestock enterprises – acceptable in terms of agricultural land, sufficient for the manure into the soil in the appropriate proportions.
3. The properties of produced manure, its quantity and storage period must be taken

into account. In accordance with the methods of optimal control of a term manure storage must be at least 6-8 months.

4. To carry out calculations of livestock at livestock enterprises acceptable in terms of agricultural land, sufficient for the manure into the soil in the appropriate proportions. Regularly making the calculation of the balance of nutrients to the soil in the fields of livestock waste management systems that need to avoid "over-fertilization" of the soil.
5. In most livestock enterprises there is no regular monitoring of atmospheric air, soil, groundwater quality and surface water. It is recommended to develop and implement a system for monitoring the status of these components of the environment. This will facilitate accurate assessment of the existing problems, determine their causes and developing measures to reduce pollution, minimize or eliminate adverse impacts.

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