MODELLING OF THE INTRAECONOMIC CARGO TRANSPORTATION BY OPTIMIZATION OF THE SIZES OF AGRICULTURAL ENTERPRISES

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Abstract. Article is devoted to mathematical modeling of an intraeconomic cargo transportation in agricultural industry. The interrelation of the sizes of the entity, amounts and the cost of intraeconomic transportations in the agrarian entities is considered. Dependence of average distance and amount of a cargo transportation from a configuration of the parcel of land is shown. Average distances of an intraeconomic cargo transportation of specialized dairy farms with various number of permanent employees are calculated. The characteristic of an intraeconomic cargo transportation in specialized dairy farmings of optimum parameters is this: large, middle, small. Change of amounts of a cargo transportation in process of growth of productivity of dairy herd is traced. Results of optimization calculations for the model specialized dairy enterprises of the central zone of of Kuban are given.

Key-words: intraenterprises cargo transportation, agrarian enterprises, optimization, modeling, distance, area, site configuration.

The interrelation of the land sizes of the entity and cost of intraeconomic transportations, determination of rational average distances of intraeconomic transportations and the sizes of agricultural enterprises finds reflection in works of many researchers of the end of the nineteenth century and practically economists throughout all twentieth century do not remain unattended. The model offered by us allows to consider all these features by optimization of parameters of the entity, and the criterion of optimization is in number determined as average from the ravnonapravlennykh of vectors in case of addition. For accounting of transportation costs it is necessary to estimate average distances of transportations. Intraeconomic transportations depend not only on the area, but also on a configuration of the parcel of land. Average distance for the same configuration of the parcel of land in case of identical placement of the economic center in direct ratio to a square root from the area (table 1).

Table 1– Average distances of an intraeconomic cargo transportation of specialized dairy farms, meters

Configuration of the parcel of land	Formulas for calculation	Farms with number of permanent employees, persons.		
		3	5	10
productivity of cows of 4500 kg				
Circle	$\frac{2}{3}\sqrt{\frac{P}{\pi}}$	209	272	387
Hexagon	$0,377\sqrt{P}$	210	273	388
Square	$0,383\sqrt{P}$	213	277	394
Rectangle (1:3)	$0,475\sqrt{P}$	264	344	489
productivity of cows of 5000 kg				
Circle	$\frac{2}{3}\sqrt{\frac{P}{\pi}}$	221	287	408
Hexagon	$0,377\sqrt{P}$	222	288	410
Square	$0,383\sqrt{P}$	225	292	416
Rectangle (1:3)	$0,475\sqrt{P}$	279	362	516
productivity of cows of 6000 kg				
Circle	$\frac{2}{3}\sqrt{\frac{P}{\pi}}$	234	305	434
Hexagon	$0,377\sqrt{P}$	235	306	435
Square	$0,383\sqrt{P}$	239	311	442
Rectangle (1:3)	$0,475\sqrt{P}$	296	386	548

Really average distances depend not only on a configuration and the area of the parcel of land, but also on placement of a road net, an arrangement of the economic center. The more land area of economy, the is more cost of intraeconomic transportations both counting on all economy in general, and per unit of the received product.

Those years optimization methods and modeling of economic systems have not been developed yet, and the first computers will appear three decades later and A. V. Chayanov, using graphical creations, algebraic transformations, finds the mathematical solution close to optimum values, offers interesting mathematical formulas for determination of the rational sizes of the agrarian entities taking into account costs for intraeconomic transportations. Modern models of optimization of parameters of the agrarian entities allow to include directly in model intraeconomic transportations as separate restriction.

In the options of a task of optimization of parameters of specialized dairy farms considered above the amount of intraeconomic transportations makes small size. So, in economy with three permanent employees it is necessary to transport 596 t of freight on average distance 264 meters. It will constitute 157 t-km. Costs for intraeconomic transportations even in case of adverse conditions

will not exceed 786 rub, in case of the total amount of production costs – 480 thousand rubles that constitutes 0,16%.

In table 2 the characteristic of an intraeconomic cargo transportation is provided in specialized dairy farmings of optimum parameters in case of productivity of cows of 6 thousands kg a year. With increase in the sizes of the entity its land territory increases, the mass of the transported freights grows and the average distance of transportations increases. All this leads to significant increase in costs for an intraeconomic cargo transportation.

Table 2 – An intraeconomic cargo transportation in specialized dairy farmings of optimum parameters

Enterprise	Farms with number of permanent employees, persons	Area of agricultural holdings, hectare	Average distance of transportations, m	Mass of freights, t	Amount of a cargo transportation, t-km
Small	3	39	296	751	222
	5	66	386	1271	491
	10	133	548	2571	1409
Middle	30	380	932	6852	6386
	50	646	1214	11660	14156
	100	1313	1731	23681	40991
Large	300	3938	2980	71042	211705
	500	6603	3860	119124	459819

In all cases, the more land area of economy, the is more cost of intraeconomic transportations both counting on all economy in general, and per unit of the received product.

Change of costs for an intraeconomic cargo transportation counting on one cow and one hectare of agricultural holdings (table 3) is of interest.

Table 3 – Amounts of an intraeconomic cargo transportation in specialized dairy farmings, t-km

Enterprise	Productivity of cows of 4500 kg			Productivity of cows of 6000 kg		
	in total	counting on:		in total	counting on:	
		1 cow	1 hectares		1 cow	1 hectares
Small	169	5,2	5,4	222	7,1	5,7
	373	6,8	7,1	491	9,2	7,4
	1072	9,7	10,1	1409	13,1	10,6
Middle	4831	15,4	16,0	6386	20,8	16,8
	10723	20,1	20,8	14156	27,1	21,9
	31019	28,6	29,7	40991	38,7	31,2
Large	160318	49,3	51,1	211705	66,6	53,8
	348054	63,8	66,2	459819	86,3	69,6

The productivity of animals, the bigger amount of an intraeconomic cargo transportation, with other things being equal, on the entity is higher. Actually it speaks simply – it is required to a highly productive cow more and the best forages. Or in a different way: it is possible to support by the best feeding the high level of productivity of cows. With increase in productivity of cows at each head the big fodder area is required, and the land territory of economy increases, so, also the amount of an intraeconomic cargo transportation on 1 hectare of the farmland increases.

For example, the area of economy with 500 permanent employees in case of productivity of 4500 kg constitutes 5259 hectares, and in case of productivity of cows in 6000 kg – already 6603 hectares. Also the structure of forages changes. But the main dependence here another – with increase in number of workers at economy grows a livestock of cows and amount of an intraeconomic cargo transportation. In small-scale enterprises the amount of an intraeconomic cargo transportation makes hundreds of ton-kilometers, averages – tens of thousands, and in large – already hundreds of thousands of ton-kilometers.

By the analysis it is established that in process of growth of the sizes of dairy farmings on land area amounts of an intraeconomic cargo transportation and costs for them increase. The specific weight of expenses on intraeconomic transportations increases in structure of product cost (table 4).

Table 4 – Expenses on an intraeconomic cargo transportation in specialized dairy farmings

Enterprise	Farms with number of permanent employees, persons	Expenses on intraeconomic transportations in % to production costs	
		in case of a yield of milk of 4500 kg	in case of a yield of milk of 6000 kg
Small	3	0,2	0,2
	5	0,2	0,3
	10	0,3	0,4
Middle	30	0,5	0,6
	50	0,7	0,8
	100	1,0	1,2
Large	300	1,6	2,1
	500	2,1	2,7

In small-scale enterprises on one cow the amount of an intraeconomic cargo transportation makes up to 13 ton-kilometers, in averages – from 15 to 40, and in large – from 50 to 90 ton-kilometers. Similarly amounts of an intraeconomic cargo transportation and per one hectare of agricultural holdings change. So, in small-scale enterprises on one hectare of agricultural holdings an intraeconomic cargo transportation constitutes 5-10 ton-kilometers, in averages – 16-30 and 50-70 ton-kilometers in large-scale specialized dairy farmings.

In small-scale enterprises specific weight of costs for intraeconomic transportations in total production expenses of economy insignificant also occupies less than a half of percent, in averages – increases up to one percent, and in large already increases to three percent. Increase in a share of expenses on intraeconomic transportations naturally eats a part of profit and interferes with production efficiency growth.

Modeling and optimization calculations are efficient tool means of the analysis of an economic situation and synthesis of optimal management decisions in agrarian and industrial complex.

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