МЕНЕДЖМЕНТ

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H. Yu. Rodashchuk, Candidate of Economic Sciences,
O. S. Solskyi, Candidate of Engineering Sciences,
T. O. Kutkovetska, Candidate of Economic Sciences

USE OF INFORMATIONAL TECHNOLOGIES IN THE LOGISTICS ACTIVITIES OF AGRICULTURAL ENTERPRISES

Urgency of the research. *The article deals with the issues of the importance of the information technologies use in the logistics activities of agricultural enterprises, for example in distribution and transport logistics.*

Target setting. *It is reasonable to develop practical proposals on the use of information technologies in the logistics activities of agricultural enterprises, particularly in distribution and transport logistics.*

Actual scientific researches and issues analysis. *Scientific papers of such scholars as M. Vakhovska, O. Deriuhin, V. Lytvyn, S. Fedoriachenko, R. Ivanov, S. Bilan, O. Karpenko, V. Tyshuk, A. Pasichnyk, S. Kravchuk, V. Kutyriev, A. Rodymchenko and others have dealt with the definition of the location of the distribution centre.*

Uninvestigated parts of general matters defining. *However, the issues of informational technologies use in the logistics activities of agricultural enterprises were not reflected in the scientific papers of the above-mentioned scholars.*

The research objective. *The article aims to scientifically prove the theoretical and methodological provisions and development of practical proposals on the information technologies use in the logistics activities of agricultural enterprises.*

The statement of basic materials. *The basic approaches to determine the location of logistics centres on the certain territory were offered, in particular the use of a sample point method and method of determining the centre of gravity. During the research it was proved that it is reasonable to use the spreadsheet MS Excel.*

Conclusions. *Logistics centres have to be located in the comfortable areas as to agricultural enterprises that will allow minimizing the transportation costs. They also have to be profitable in terms of transport accessibility and transport link.*

Keywords: *information technologies; logistics centre; transport network.*

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Г. Ю. Родащук, к. е. н.,
О. С. Сольський, к. т. н.,
Т. О. Кутковецька, к. е. н.

ВИКОРИСТАННЯ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ У ЛОГІСТИЧНІЙ ДІЯЛЬНОСТІ СІЛЬСЬКОГОСПОДАРСЬКИХ ПІДПРИЄМСТВ

Актуальність теми дослідження. *У статті висвітлюються питання актуальності застосування інформаційних технологій у логістичній діяльності сільськогосподарських підприємств, приміром в розподільчій та транспортній логістиці.*

Постановка проблеми. *Доцільним є розробка практичних пропозицій щодо використання інформаційних технологій в логістичній діяльності сільськогосподарських підприємств, зокрема в розподільчій та транспортній логістиці.*

Аналіз останніх досліджень і публікацій. *Наукові праці таких вчених, як М. Ваховська, О. Дерюгін, В. Литвин, С. Федоряченко, Р. Іванов, С. Білан, О. Карпенко, В. Тишук, А. Пасічник, С. Кравчук, В. Кутирєв, А. Родимченко та інші мали справу з визначенням місця розташування розподільного центру.*

Виділення недосліджених частин загальної проблеми. *У працях науковців не знайшли відображення питання щодо використання інформаційних технологій в логістичній діяльності сільськогосподарських підприємств.*

Постановка завдання. *Стаття покликана науково обґрунтувати теоретико-методичні положення та розробку практичних пропозицій щодо використання інформаційних технологій в логістичній діяльності сільськогосподарських підприємств.*

Виклад основного матеріалу. *Запропоновано основні підходи щодо визначення місця розташування логістичних центрів на певній території, зокрема використання методу пробної точки та методу визначення центру ваги. У ході досліджень було обґрунтовано, що для цього доцільно скористатися табличним процесором MS Excel.*

Висновки. *Логістичні центри мають розміщуватися в комфортних зонах відносно сільськогосподарських підприємств, що дозволить мінімізувати витрати на транспортування, а також мають бути вигідними з точки зору транспортної доступності та транспортного сполучення.*

Ключові слова: *інформаційні технології; логістичний центр; транспортна мережа.*

Urgency of the research. Nowadays the production management efficiency largely depends on information provision and completeness of information. The rapid development of information technology, consisting of computerization and telecommunications, makes significant changes in all aspects of business, including logistics and business activity. The problem of information support in each stage

of the distribution and transport processes in the production of agricultural products will always remain relevant.

As agricultural production requires constant management of cargo transportation, it is necessary to implement logistics centres with specialized technical equipment which will ensure the functioning of the transport and logistics system. As the result it will be possible to store agricultural products with minimal losses for a long time. The usage of specialized equipment will enable a faster and better technological process. Thus, one of the most important and difficult task when designing logistics systems is the choice of options for the location of the logistics centre.

Target setting. It makes sense to develop practical proposals on the use of information technology in the logistics of agricultural enterprises, particularly in distribution and transport logistics.

Actual scientific researches and issues analysis. Some fundamental aspects of the creation and operation of logistics centres in Ukraine are theoretically grounded in the works of such local scientists and logisticians as N. M. Dashchenko [2], V. V. Makarova [6], L. V. Savchenko, L. V. Sauliak [9]. Research on the use of methods for determining the location of the distribution centre was conducted by such economists such as M. Yu. Vakhovska [1], O. V. Deriuhin, V. V. Lytvyn, S. O. Fedoriachenko [3], R. V. Ivanov, S. O. Bilan [4], O. A. Karpenko, V. P. Tyshuk [5], A. M. Pasichnyk, S. S. Kravchuk, V. V. Kutyriev [7], and A. O. Rodymchenko [8].

Uninvestigated parts of general matters defining. Scientists have not worked out the issue of the use of information technology in the logistics of agricultural enterprises yet.

The research objective. The article deals with the scientific study of theoretical and methodological development of policies and practical proposals for the use of information technology in the logistics of agricultural enterprises, including location of the logistics centre.

The statement of basic materials. While determining the most favorable (optimal) number of logistics centres an optimization problem arises: if to increase their number in the distribution network, the cost of transport and processing orders fall, the cost of maintaining inventory increases, and total costs reach a minimum for a certain amount of logistics distribution centres. One of the important prerequisites for solving the above optimization problem is the positioning of logistics centres. Different methods can be used: the method of a full search, heuristic methods, the method of determining the centre of gravity, method of a test point [3; 5; 6].

Since in practice in terms of extensive transport network the method of full search may be unsuitable because the number of possible options with the increase of the network scaling increases exponentially, as well as the complexity of the solution, and heuristic methods are based on human experience and intuition, so to locate logistics centres, we must consider the method of determining the centre of gravity method and the test points method.

It should be noted that the use of modern information technology influences the choice of software: based on a software package of MS Office or a specialized one. The complex of MS Office applications is interconnected and is designed to solve almost any problems. Since the currently marketed software hasn't presented products that automate the process of solving these problems and MS Excel spreadsheet is available for everyone, so we can use them to determine the location of a logistics centre for agricultural enterprises of Vinnytsia region.

To locate a logistics centre for the improvement of the logistics governance in rural areas of Vinnitsa region, we will at first apply the method of determining the centre of gravity. We use a method of an applying the coordinates network for the map of potential locations of logistics centres. The system enables the network to estimate the shipping cost from each potential supplier to the logistics centre and from that place to the end user, and it is necessary to select the desired option which is defined as the centre of mass.

Solving the problem of the distance gives the location of the geographical point coordinates where the sum of the distances to all points of demand is minimal. This approach is based on the assumption that transportation costs depend on the distance. Thus, it is assumed that it is necessary to minimize the total distance traffic and obtain the optimal location for a logistics centre.

The coordinates of the centre of gravity of cargo flows where a logistics centre can be located are determined by formulas [4; 5; 9]:

$$X = \frac{\sum_{i=1}^{n} B_i X_i}{\sum_{i=1}^{n} B_i}, \quad (1)$$

$$Y = \frac{\sum_{i=1}^{n} B_i Y_i}{\sum_{i=1}^{n} B_i}, \quad (2)$$

where X, Y – coordinates of the centre of gravity of cargo flows;
B_i – cargo turnover of the i-manufacturer (consumer);
X_i, Y_i – the coordinates and the i-manufacturer (consumer);
n – the number of producers (consumers).

Using MS Excel spreadsheet, using Formula 1 and 2, coordinating the location of a logistics centre (LC) for agricultural enterprises of Vinnytsya region [10]. Thus, using the method of determining the centre of gravity we obtained the optimal location coordinates of a logistics centre for agricultural enterprises of Vinnytsya region – X = 48,9780; Y = 28,7253. Such territorial location will minimize transport costs from enterprises to a logistics centre (Fig. 1).

	A	B	C	D	E	F	G	H	I
1	**Output to locate a logistics center for agricultural enterprises of Vinnytsia region**					**Calculated data**			
2	№	Regional centers	Coordinates X_i	Coordinates Y_i	Cargo turnover (Bi), ths. tons	$B_i \cdot X_i$	$B_i \cdot Y_i$	Coordinates LC	
3								X	Y
4	1	Bar	49,0749	27,6831	4345,8	213269,7	120305,2	***48,9780***	***28,7253***
5	2	Bershad	48,4328	29,5254	11047,1	535042,0	326170,0		
6	3	Vinnytsia	49,2331	28,4682	6429,2	316529,4	183027,8		
7	4	Haisyn	48,8106	29,3841	21957,9	1071778,3	645213,1		
8	5	Zhmerynka	49,0425	28,0993	2513,7	123278,1	70633,2		
9	6	Illintsi	49,1051	29,2084	5181,3	254428,3	151337,5		
10	7	Kalynivka	49,4472	28,5231	7013,6	346802,9	200049,6		
11	8	Koziatyn	49,7211	28,8342	9716,5	483115,1	280167,5		
12	9	Kryzhopil	48,3753	28,8708	20581,8	995650,7	594213,0		
13	10	Lypovets	49,2161	29,0561	10930,6	537961,5	317600,6		
14	11	Lityn	49,3273	28,0836	2247,7	110873,0	63123,5		
15	12	Mohyliv-Podilskyi	48,4410	27,8022	9858,8	477570,1	274096,3		
16	13	Murovani Kurylivtsi	48,7222	27,5153	3143,4	153153,4	86491,6		
17	14	Nemyriv	48,9794	28,8438	5103,4	249961,5	147201,4		
18	15	Orativ	49,1761	29,3910	11480,8	564581,0	337432,2		
19	16	Pishchanka	48,2057	28,8891	1972,1	95066,5	56972,2		
20	17	Pohrebyshche	49,4870	29,2734	14134,9	699493,8	413776,6		
21	18	Teplyk	48,6595	29,7540	3920,0	190745,2	116635,7		
22	19	Tyvriv	49,0122	28,5038	4803,8	235444,8	136926,6		
23	20	Tomashpil	49,5427	28,1200	12551,2	621820,3	352939,7		
24	21	Trostianets	48,5128	29,2277	11948,1	579635,8	349215,5		
25	22	Tulchyn	48,6734	28,8546	14670,7	714072,8	423317,2		
26	23	Khmilnyk	49,5581	27,9560	28530,7	1413927,3	797604,2		
27	24	Chernivtsi	48,5427	28,1074	2527,7	122701,4	71047,1		
28	25	Chechelnyk	48,2165	29,3482	2066,1	99620,1	60636,3		
29	26	Sharhorod	48,7533	28,0825	6856,6	334281,9	192550,5		
30	27	Yampil	48,2351	28,2779	6528,2	314888,4	184603,8		
31	∑				**242061,7**	**11855693,2**	**6953288,0**		

Fig. 1. Determination of the location coordinates of a logistic centre using the method of determining the centre of gravity

Source: based on [10]

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We can determine the best location for a logistics centre with the further analysis of possible locations. To do this, we use the method of test points which allows to determine the optimal location of a logistics centre in case of a rectangular configuration of network of roads. The essence of this method is to check each successive segment of the areas served. A trial segment point is any point that is on this segment and is not one of its ends. A left cargo turnover of a test point is the cargo turnover of producers (consumers) located throughout the service area to the left of this point. A right cargo turnover of a test point is the cargo turnover of producers (consumers) located to the right of it [5].

The area service should begin with checking its leftmost end. At first we should analyze the first leg section: this section refers to the test point and the amount of cargo turnover of producers (consumers) who are in the left and in the right of a set point. If the cargo turnover of producers (consumers) who are in the right is more, we check the next segment if it is smaller, and we make the decision on expediency of placing a logistics centre at the beginning of the segment that was tested. We should note that the test of test points is carried out until it finds a point for which the amount of cargo turnover of producers (consumers) on the left side does not exceed the amount of cargo turnover of producers (consumers) on the right side. After that a decision on the location of a logistics centre is made at the beginning of the segment that is in left of the test points [5].

To use the point test method to determine coordinates for the location of optimal unit of the transport network, with a purpose to locate the logistics centre there for agricultural enterprises of Vinnytsia region, it is necessary to place coordinate axes oriented parallel to the road. Therefore, using the possibilities of the MS Excel spreadsheet, we should build a dot diagram which will show the placement of regional centres of Vinnitsa region regarding to their geographical coordinates. For this, the latitude coordinates will be placed on the X axis of the chart and the longitude coordinates – on the Y axis (Fig. 2).

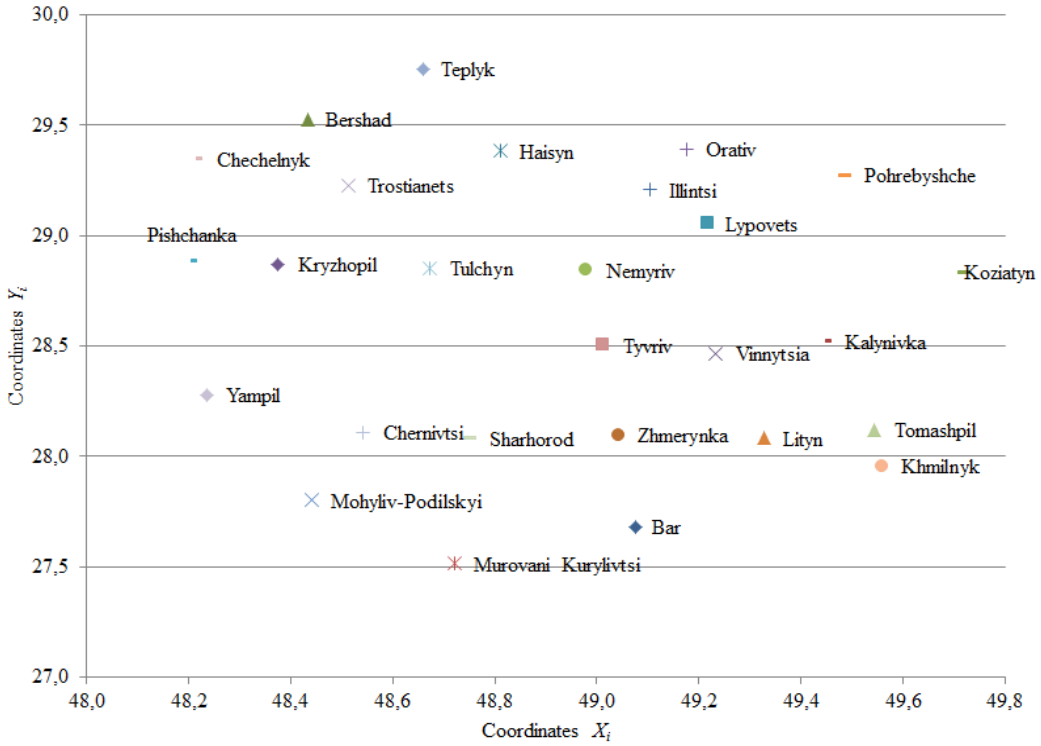

Fig. 2. Dot diagram of the location of Vinnitsya region regional centres

Having determined the coordinates of producers (consumers), it is necessary to find on each axis an optimal location in terms of a logistics centre by a test point method, i.e. X and Y coordinates of the

desired site. Since the calculations are done separately for each axis, we must first sort the source data coordinates along column *Coordinates* X_i in ascending order. We should find left and right cargo turnover points on each test interval, compare and identify the *X* coordinate for the best location of a logistics centre. Analyzing the data, it can be concluded that as a test point on the segment Nemiroff – Tyvriv the right cargo turnover is less than the left, we make the conclusion that coordinate *X* corresponds to the start point of the segment with coordinate 48,9794 (Fig. 3).

	A	B	C	D	E	F	G	H
1	Output to locate a logistics center for agricultural enterprises of Vinnytsia region					Calculated data		
2	№	Regional centers	Coordinates X_i	Coordinates Y_i	Cargo turnover (Bi), ths. tons	Test point cargo turnover		Difference
3						Left	Right	
4	1	Pishchanka	48,2057	28,8891	1972,1	1972,1		
5	2	Chechelnyk	48,2165	29,3482	2066,1	4038,2	240089,6	-238117,5
6	3	Yampil	48,2351	28,2779	6528,2	10566,4	238023,5	-233985,3
7	4	Kryzhopil	48,3753	28,8708	20581,8	31148,2	231495,3	-220928,9
8	5	Bershad	48,4328	29,5254	11047,1	42195,3	210913,5	-179765,3
9	6	Mohyliv-Podilskyi	48,4410	27,8022	9858,8	52054,1	199866,4	-157671,1
10	7	Trostianets	48,5128	29,2277	11948,1	64002,2	190007,6	-137953,5
11	8	Chernivtsi	48,5427	28,1074	2527,7	66529,9	178059,5	-114057,3
12	9	Teplyk	48,6595	29,7540	3920,0	70449,9	175531,8	-109001,9
13	10	Tulchyn	48,6734	28,8546	14670,7	85120,6	171611,8	-101161,9
14	11	Murovani Kurylivtsi	48,7222	27,5153	3143,4	88264,0	156941,1	-71820,5
15	12	Sharhorod	48,7533	28,0825	6856,6	95120,6	153797,7	-65533,7
16	13	Haisyn	48,8106	29,3841	21957,9	117078,5	146941,1	-51820,5
17	14	Nemyriv	***48,9794***	28,8438	5103,4	122181,9	124983,2	-7904,7
18	15	Tyvriv	49,0122	28,5038	4803,8	126985,7	119879,8	***2302,1***
19	16	Zhmerynka	49,0425	28,0993	2513,7	129499,4	115076,0	11909,7
20	17	Bar	49,0749	27,6831	4345,8	133845,2	112562,3	16937,1
21	18	Illintsi	49,1051	29,2084	5181,3	139026,5	108216,5	25628,7
22	19	Orativ	49,1761	29,3910	11480,8	150507,3	103035,2	35991,3
23	20	Lypovets	49,2161	29,0561	10930,6	161437,9	91554,4	58952,9
24	21	Vinnytsia	49,2331	28,4682	6429,2	167867,1	80623,8	80814,1
25	22	Lityn	49,3273	28,0836	2247,7	170114,8	74194,6	93672,5
26	23	Kalynivka	49,4472	28,5231	7013,6	177128,4	71946,9	98167,9
27	24	Pohrebyshche	49,4870	29,2734	14134,9	191263,3	64933,3	112195,1
28	25	Tomashpil	49,5427	28,1200	12551,2	203814,5	50798,4	140464,9
29	26	Khmilnyk	49,5581	27,9560	28530,7	232345,2	38247,2	165567,3
30	27	Koziatyn	49,7211	28,8342	9716,5		9716,5	222628,7

a) Result

	F	G	H
1	Calculated data		
2	Test point cargo turnover		Difference
3	Left	Right	
4	=E4		
5	=SUM($E$4:E5)	=SUM(E5:$E$30)	=F4-G5
6	=SUM($E$4:E6)	=SUM(E6:$E$30)	=F5-G6
7	=SUM($E$4:E7)	=SUM(E7:$E$30)	=F6-G7
8	=SUM($E$4:E8)	=SUM(E8:$E$30)	=F7-G8
9	=SUM($E$4:E9)	=SUM(E9:$E$30)	=F8-G9
10	=SUM($E$4:E10)	=SUM(E10:$E$30)	=F9-G10
11	=SUM($E$4:E11)	=SUM(E11:$E$30)	=F10-G11
12	=SUM($E$4:E12)	=SUM(E12:$E$30)	=F11-G12
13	=SUM($E$4:E13)	=SUM(E13:$E$30)	=F12-G13
14	=SUM($E$4:E14)	=SUM(E14:$E$30)	=F13-G14
15	=SUM($E$4:E15)	=SUM(E15:$E$30)	=F14-G15
16	=SUM($E$4:E16)	=SUM(E16:$E$30)	=F15-G16
17	=SUM($E$4:E17)	=SUM(E17:$E$30)	=F16-G17
18	=SUM($E$4:E18)	=SUM(E18:$E$30)	***=F17-G18***
19	=SUM($E$4:E19)	=SUM(E19:$E$30)	=F18-G19
20	=SUM($E$4:E20)	=SUM(E20:$E$30)	=F19-G20
21	=SUM($E$4:E21)	=SUM(E21:$E$30)	=F20-G21
22	=SUM($E$4:E22)	=SUM(E22:$E$30)	=F21-G22
23	=SUM($E$4:E23)	=SUM(E23:$E$30)	=F22-G23
24	=SUM($E$4:E24)	=SUM(E24:$E$30)	=F23-G24
25	=SUM($E$4:E25)	=SUM(E25:$E$30)	=F24-G25
26	=SUM($E$4:E26)	=SUM(E26:$E$30)	=F25-G26
27	=SUM($E$4:E27)	=SUM(E27:$E$30)	=F26-G27
28	=SUM($E$4:E28)	=SUM(E28:$E$30)	=F27-G28
29	=SUM($E$4:E29)	=SUM(E29:$E$30)	=F28-G29
30		=SUM(E30:$E$30)	=F29-G30

b) Formulas

Fig. 3. Determination of X coordinate by the test point for the optimal location of a logistics centre
Source: based on [10]

The next step is to find Y coordinate on a coordinate axis of ordinates for the successful location of a logistics centre. We must sort the output data in the column of coordinate Y_i in ascending order. A further algorithm is similar to determine the coordinates *X*. Having determined that a test point on the segment Tulchyn – Kryzhopil the right cargo turnover is less than the left one, we decided that coordinate *Y* corresponds the point on the beginning of the segment, in this case, the geographical coordinate is 28,8546 (Fig. 4).

Thus, using the method of a test point we determined that the coordinates of the optimal location of a logistics centre for agricultural enterprises of Vinnytsya region are – X = 48,9794; Y = 28,8546.

As the results concerning the location of a logistics centre were divergent, we should examine the transportation work which is in progress in the two sites (i.e. compare the total cargo turnover). The method of a partial enumeration should be selected a by site of a transport network, which may be the

location of a logistics centre. Then we should determine the distance from the site to each of the producers (consumers) according to the areas of the transport network. The total cargo turnover from some transport site will be equal to the sum of the relevant cargo turnover for other sites (producers or consumers) [8]:

$$P_j = \sum_{i=1}^{n} B_i \cdot L_{j-i} \rightarrow \min, \quad (3)$$

where P_j – the total cargo turnover of transport on delivery of goods in terms in all points of the *j*-site;

B_i – cargo turnover of the *i*-manufacturer (consumer);

L_{j-i} – the distance from *j*-site to the *i*-manufacturer (consumer);

n – the number of producers (consumers).

	A	B	C	D	E	F	G	H
1	Output to locate a logistics center for agricultural enterprises of Vinnytsia region					Calculated data		
2	№	Regional centers	Coordinates X_i	Coordinates Y_i	Cargo turnover (Bi), ths. tons	Test point cargo turnover		Difference
3						Left	Right	
4	1	Murovani Kurylivtsi	48,7222	27,5153	3143,4	3143,4		
5	2	Bar	49,0749	27,6831	4345,8	7489,2	238918,3	-235774,9
6	3	Mohyliv-Podilskyi	48,4410	27,8022	9858,8	17348,0	234572,5	-227083,3
7	4	Khmilnyk	49,5581	27,9560	28530,7	45878,7	224713,7	-207365,7
8	5	Sharhorod	48,7533	28,0825	6856,6	52735,3	196183,0	-150304,3
9	6	Lityn	49,3273	28,0836	2247,7	54983,0	189326,4	-136591,1
10	7	Zhmerynka	49,0425	28,0993	2513,7	57496,7	187078,7	-132095,7
11	8	Chernivtsi	48,5427	28,1074	2527,7	60024,4	184565,0	-127068,3
12	9	Tomashpil	49,5427	28,1200	12551,2	72575,6	182037,3	-122012,9
13	10	Yampil	48,2351	28,2779	6528,2	79103,8	169486,1	-96910,5
14	11	Vinnytsia	49,2331	28,4682	6429,2	85533,0	162957,9	-83854,1
15	12	Tyvriv	49,0122	28,5038	4803,8	90336,8	156528,7	-70995,7
16	13	Kalynivka	49,4472	28,5231	7013,6	97350,4	151724,9	-61388,1
17	14	Koziatyn	49,7211	28,8342	9716,5	107066,9	144711,3	-47360,9
18	15	Nemyriv	48,9794	28,8438	5103,4	112170,3	134994,8	-27927,9
19	16	Tulchyn	48,6734	***28,8546***	14670,7	126841,0	129891,4	-17721,1
20	17	Kryzhopil	48,3753	28,8708	20581,8	147422,8	115220,7	***11620,3***
21	18	Pishchanka	48,2057	28,8891	1972,1	149394,9	94638,9	52783,9
22	19	Lypovets	49,2161	29,0561	10930,6	160325,5	92666,8	56728,1
23	20	Illintsi	49,1051	29,2084	5181,3	165506,8	81736,2	78589,3
24	21	Trostianets	48,5128	29,2277	11948,1	177454,9	76554,9	88951,9
25	22	Pohrebyshche	49,4870	29,2734	14134,9	191589,8	64606,8	112848,1
26	23	Chechelnyk	48,2165	29,3482	2066,1	193655,9	50471,9	141117,9
27	24	Haisyn	48,8106	29,3841	21957,9	215613,8	48405,8	145250,1
28	25	Orativ	49,1761	29,3910	11480,8	227094,6	26447,9	189165,9
29	26	Bershad	48,4328	29,5254	11047,1	238141,7	14967,1	212127,5
30	27	Teplyk	48,6595	29,7540	3920,0		3920,0	234221,7

a) Result

F	G	H
Calculated data		
Test point cargo turnover		Difference
Left	Right	
=E4		
=SUM($E$4:E5)	=SUM(E5:$E$30)	=F4-G5
=SUM($E$4:E6)	=SUM(E6:$E$30)	=F5-G6
=SUM($E$4:E7)	=SUM(E7:$E$30)	=F6-G7
=SUM($E$4:E8)	=SUM(E8:$E$30)	=F7-G8
=SUM($E$4:E9)	=SUM(E9:$E$30)	=F8-G9
=SUM($E$4:E10)	=SUM(E10:$E$30)	=F9-G10
=SUM($E$4:E11)	=SUM(E11:$E$30)	=F10-G11
=SUM($E$4:E12)	=SUM(E12:$E$30)	=F11-G12
=SUM($E$4:E13)	=SUM(E13:$E$30)	=F12-G13
=SUM($E$4:E14)	=SUM(E14:$E$30)	=F13-G14
=SUM($E$4:E15)	=SUM(E15:$E$30)	=F14-G15
=SUM($E$4:E16)	=SUM(E16:$E$30)	=F15-G16
=SUM($E$4:E17)	=SUM(E17:$E$30)	=F16-G17
=SUM($E$4:E18)	=SUM(E18:$E$30)	=F17-G18
=SUM($E$4:E19)	=SUM(E19:$E$30)	=F18-G19
=SUM($E$4:E20)	=SUM(E20:$E$30)	***=F19-G20***
=SUM($E$4:E21)	=SUM(E21:$E$30)	=F20-G21
=SUM($E$4:E22)	=SUM(E22:$E$30)	=F21-G22
=SUM($E$4:E23)	=SUM(E23:$E$30)	=F22-G23
=SUM($E$4:E24)	=SUM(E24:$E$30)	=F23-G24
=SUM($E$4:E25)	=SUM(E25:$E$30)	=F24-G25
=SUM($E$4:E26)	=SUM(E26:$E$30)	=F25-G26
=SUM($E$4:E27)	=SUM(E27:$E$30)	=F26-G27
=SUM($E$4:E28)	=SUM(E28:$E$30)	=F27-G28
=SUM($E$4:E29)	=SUM(E29:$E$30)	=F28-G29
	=SUM(E30:$E$30)	=F29-G30

b) Formulas

Fig. 4. Determination of Y coordinate for the optimal location of a logistics centre by a test point method
Source: based on [10]

As shown in Formula 3, the site of the transport network which will provide a minimum cargo turnover of P_j, transport, will be the best location for a logistics centre (Fig. 5).

Thus, as a result of payments received we can conclude that the best place of the location of a logistics centre for agricultural enterprises of Vinnytsia region is site number 2 (the location that was found by the method of a test point) with coordinates X = 48,9794; Y = 28,8546 since it overall cargo turnover is less than in site number 1.

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These coordinates refer to rural areas not far from the village Medvezha of Nemyrivskyi region. It should be noted that at the village there are two roads, the first one of a regional importance – highway P36, the other is of an international importance – M12 (Stryi – Ternopil – Vinnytsia – Kropyvnytskyi – Znamianka). Thus, such a location of a logistics centre will be beneficial in terms of traffic and transport accessibility.

	A	B	C	D	E	F	G
1	№	Regional centers	Cargo turnover, ths. tons	Transport cargo turnover			
2				For site №1		For site №2	
3				The distance from a logistics center, km	Cargo turnover	The distance from a logistics center, km	Cargo turnover
4	1	Bar	4345,8	130	564954,0	120	521496,0
5	2	Bershad	11047,1	110	1215181,0	110	1215181,0
6	3	Vinnytsia	6429,2	55	353606,0	48	308601,6
7	4	Haisyn	21957,9	59	1295516,1	52	1141810,8
8	5	Zhmerynka	2513,7	110	276507,0	99	248856,3
9	6	Illintsi	5181,3	35	181345,5	32	165801,6
10	7	Kalynivka	7013,6	79	554074,4	72	504979,2
11	8	Koziatyn	9716,5	130	1263145,0	120	1165980,0
12	9	Kryzhopil	20581,8	96	1975852,8	89	1831780,2
13	10	Lypovets	10930,6	53	579321,8	51	557460,6
14	11	Lityn	2247,7	94	211283,8	87	195549,9
15	12	Mohyliv-Podilskyi	9858,8	120	1183056,0	110	1084468,0
16	13	Murovani Kurylivtsi	3143,4	42	132022,8	130	408642,0
17	14	Nemyriv	5103,4	9	45930,6	2	10206,8
18	15	Orativ	11480,8	67	769213,6	64	734771,2
19	16	Pishchanka	1972,1	120	236652,0	110	216931,0
20	17	Pohrebyshche	14134,9	85	1201466,5	82	1159061,8
21	18	Teplyk	3920	98	384160,0	91	356720,0
22	19	Tyvriv	4803,8	54	259405,2	47	225778,6
23	20	Tomashpil	12551,2	73	916237,6	66	828379,2
24	21	Trostianets	11948,1	83	991692,3	76	908055,6
25	22	Tulchyn	14670,7	47	689522,9	40	586828,0
26	23	Khmilnyk	28530,7	120	3423684,0	120	3423684,0
27	24	Chernivtsi	2527,7	98	247714,6	91	230020,7
28	25	Chechelnyk	2066,1	120	247932,0	120	247932,0
29	26	Sharhorod	6856,6	90	617094,0	83	569097,8
30	27	Yampil	6528,2	120	783384,0	110	718102,0
31	**Total cargo turnover (P_j)**		**x**	**x**	**20599955,5**	**x**	***19566175,9***

Fig. 5. Determination of the total cargo turnover in the received sites of the location of a logistics centre of a transport network of Vinnytsia region

Source: based on [10]

Conclusions. Nowadays it is impossible to provide a quality management of agricultural production without the introduction and application of information systems and technologies. It is their use in practice that enforces agricultural enterprises complex interacting and complementary requirements that shape the quality of services, as information technology plays an important role in strategic management, planning and achieving the goals of the company.

Of all the above mentioned we can clearly see the selection of proper location of a logistics centre. The choice of location of a logistics centre is an important step in the logistics of agricultural enterprises, particularly in distribution and transport logistics. Recommendations for optimal placement of regional logistics centre of agricultural enterprises are based on the principle of mutually beneficial and economically viable location for definition of warehouses as producers and consumers of their products. However, it should be noted that the choice of a location of a logistics centre should consider not only the location of customers and suppliers, but also such factors as availability of transport areas.

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