International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 406-417 www.ijaem.net ISSN: 2395-5252

Determination of the Volume of Transport Operations When Transporting White Cabbage Variety "Dabene 5" From the Plantation to the Regional Vegetable Market

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Date of Submission: 11-03-2024 Date of Acceptance: 21-03-2024

ABSTRACT: The article presents the results of the study of the regional white head cabbage variety "Dabene 5" and the transport operations from the plantation through its owner's base to the regional vegetable market in the regional city. 10 plantations with different area and location were examined. The average mass of one cabbage $\mathbf{m_z}$ = 2.97 kg and the reasons for its value were determined. Based on the 3 types of means of transport used by the local population for the transport of vegetable produce and their carrying capacity, schemes are proposed for combining them in order to reduce overloading or under loading. The vehicles are combined in different variations of types and number of one type in the combination in order to find the maximum of the load capacity utilization factor. For given variations, this coefficient reaches a possible maximum of 100%. For plantations N1 and N10, the maximum possible reaches 92% with the set parameters. A proposal was made to cooperate and use means of transport with greater load capacity. Measures aimed at increasing production, and hence the volume of transport operations, have been proposed.

KEYWORDS: White cabbage variety "Dabene 5", transport operations, means of transport, load capacity utilization factor

I. INTRODUCTION

Cabbage is a traditional vegetable crop in the Republic of Bulgaria. It has been used for generations as one of the main products for preparing dishes with or without meat. It is present on the table in different processing options. From chopped raw for salads, through thermally processed vegetables and baked goods, to canned - "sauerkraut" and pickles.

According to the website Gotvach.bg [1], 417 recipes are listed in the "Main Dishes with Sauerkraut" section. On the same site, 82 recipes for "Zelnik" are given. (Cabbage is a popular dish in Bulgaria and is prepared in many different variations. The main ingredients are sauerkraut, which is finely chopped and stewed with oil, onions and spices. Then the filling is added, which can be cheese, eggs , meat or vegetables [2]).

Before it was considered a food, cabbage was valued for medicinal purposes in the treatment of headaches, gout, diarrhea and peptic ulcers [3, 4].

Cabbage is a cruciferous vegetable that is rich in minerals, vitamin C, dietary fiber and especially phytochemicals [5, 6].

Many epidemiological studies and intervention trials have shown that this cruciferous vegetable is beneficial in reducing the risk of several types of cancer, as well as other chronic diseases such as cardiovascular disease, cataracts, Alzheimer's disease and diabetes, due to its nutritional composition with its wide range of antioxidants and phytochemicals, including carotenoids, glucosinolates, isothiocyanates, phenolic compounds, and vitamins E and C [7].

These compounds help activate and stabilize the body's antioxidant and detoxification mechanisms that break down and eliminate cancer-causing substances [3, 8, 9].

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Nieuwhof (1969) and Jagdish Singh et al (2006) categorized the different forms of cultivated cabbage into white cabbage, red cabbage and savoy cabbage. [3, 10].

There is a forgotten old regional variety of white cabbage named after the place where it was grown - the village of Dabene.

The village of Dabene (Fig. 1.) is located in the flat part of the Stryama Valley, 5 kilometers from the municipal center of Karlovo. South of the village runs the river Stryama [11].

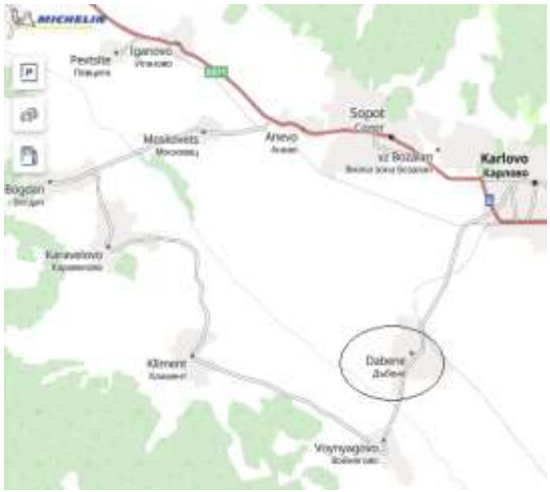

Figure1. Road map Dabene village – Karlovo city
Source: https://www.viamichelin.com/ [12]

The municipality of Karlovo is located in the central part of Bulgaria and the northern part of the Plovdiv region on an area of 1044 km^2, and represents 1% of the country's territory. It is one of the 20 largest municipalities in Bulgaria. It consists of 4 cities - Karlovo, Kalofer, Banya, Klisura and 23 villages [13, 14].

Years ago, the famous white cabbage variety "Dabene No. 5" came from the village of Dabene. The vegetable white Dabensko head cabbage was registered in 1970 in the Bulgarian Academy of Sciences genus No. 5. It is grown only in this village [13, 14].

Daben cabbage was first studied in geography textbooks in 1962. The variety continues to be grown in people's yards. Around Dimitrovden, everyone from the surrounding settlements buys cabbage. It is extremely tender, tasty and suitable for preparing meals and winter dishes [15] (Dimitrovden is a national and Orthodox holiday[16]).

According to Chapanski [17], already in the 70s of the last century, precisely from Dabene, the famous variety of white head cabbage "Dabene No. 5", extremely tasty, tender and suitable for imposing in winter, also started.

According to another author [18], the cabbage, which is the business card of the settlement, is known as White Cabbage - Dubene No. 5. It is characterized by medium-sized cabbages. Extremely tender and delicious.

We also learn about the taste qualities from the author Georgieva [19], who wrote that Daben cabbage is the best - white, fragile, sweet, it makes the best salads, pickles and feasts.

In addition to their own consumption, the population of the village of Dabene also grew cabbage for trade. According to Zoya Stankova, after Dimitrovden, they went around villages and towns with ox carts. They sold, and in the villages west of Karlovo, cabbage was exchanged for firewood [18].

This tradition continues today, but the scale of production is fluctuating and with a tendency to disappear. During working hours (Monday to Friday), the population goes to work in the factories in the nearby towns, and agricultural production - afterwards. Cabbage is mainly grown in yards or on small areas outside the settlement.

For the mechanization of production processes, a suitable planting scheme is 90 + 70/60 cm [20]. The distance between the cabbages in the row is 50 cm (Fig. 2).

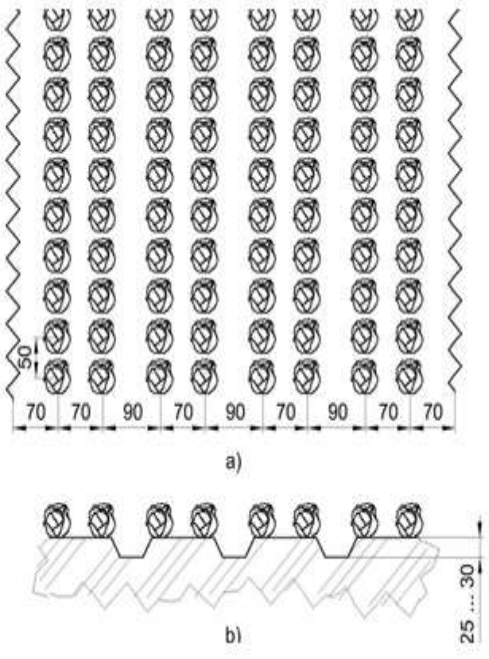

Figure 2. Scheme of growing cabbage
a) top view; b) bed profile

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To maintain the purity and its high productive qualities, several hundred elite plants are selected annually from the cabbage to produce the so-called super elite seed, which is sown and grown every year with very high agrotechnics to produce elite seed [21].

Thanks to these efforts, the regional variety has been preserved over the centuries.

The variation in the weight of cabbages is large (from 2.5 to 4.0 kg) compared to the possibility of watering, feeding and climatic conditions.

Cabbage ready for sale is transported from the field to the plantation owner's base on roads without permanent pavement.

According to Zahariev [22], both before and now, roads on which vehicles move are the so-called dirt roads, which become difficult to pass during the spring and autumn months.

Transport is by car with passenger cars or minivans according to the owners' capabilities. Most of them have single-axle car trailers up to 750 kg total weight and/or motor cultivators with implements. In the last 10 years, a small number of owners or users bought low-power tractors (up to 20-25 HP), second-hand (second-hand), mainly imported from Asian countries [23].

For transportation, the cabbages are stacked in woven nylon sacks or directly in the body of the transport vehicle.

Transport is a major structure-determining industry [22, 24 - 28].

Cabbage is also grown by large agricultural cooperatives, where each operation, the duration of the processes, the methods of transportation, the carrying capacity of the means of transport and the buyers of the finished product are pre-determined and agreed upon at the planning level.

The parameters recorded above for small producers of regional varieties, such as "Dabene 5", which is sold at the regional vegetable market, namely in the municipal center of Karlovo, remain undefined.

II. MATERIALS AND METHODS

To determine the location of the small massifs of cabbage, the settlement and the nearby plantations are visited.

For massifs outside the settlement, the distance to the owner's base is determined.

The distance from the owner's base to the vegetable market in the municipal center of Karlovo is determined.

Timing is used to determine the times of individual transport operations and calculate their volume.

The speed of movement V, km/h is determined.

$$V = \frac{S}{t}, km/h \qquad (1)$$

where: S – distance, km; t – time, s.

Mass of transported cabbage is M, t:

$$M = (n_z . F_p . m_z) /1000 \qquad (2)$$

where: nz – number of cabbages in 1 da, pcs; Fp – plantation area, da; mz – mass of one cabbage, kg.

According to Zahariev [22], the volume of transport activities Q, t.km, for each operation is determined by the dependence:

$$Q = L.M, \qquad (3)$$

where: L – transport distance, km; M – mass of transported material, t.

The mass of one cabbage mz, kg is determined by measuring 200 pieces of cabbage (20 pieces from each array) with an electronic scale with a range of 5 kg ±1g. The resulting values are added together. The sum is divided by 200.

$$m_z = \frac{\sum_{i=1}^{200} m_{zi}}{200} \qquad (4)$$

In order to reduce the costs of the survey and the carbon footprint in the atmosphere of the means of transport used in the measurement, the distance from the plantation to the vegetable market Lz, km, is divided into three parts:

- First part L_1, km – from the plantation to the owner's base;
- Second part L_2, km – from the owner's base to the railway crossing at the northern end of the village located on the road to the town of Karlovo;
- Third part L_3, km – from the railway crossing to the municipal vegetable market.

This division is also necessitated by the fact that the road is the same from the railway crossing to the municipal vegetable market.

$$Lz = L_1 + L_2 + L_3 \qquad (5)$$

Volume of transport activities from the i-th plantation to the vegetable market Q_{Ni}, t.km:

$$Q_{Ni} = Q_{1Ni} + Q_{2Ni} + Q_{3Ni} \qquad (6)$$

where: Q_{1Ni} - the volume of transport activities from the i-th plantation to the i-th base, t.km; Q_{2Ni} - the volume of transport activities from the i-th base, the collection point of the routes (railway crossing at the northern end of the village of Dabene - on the road to the city of Karlovo), t.km; Q_{3Ni} the volume of transport activities from the collection point (railway crossing) to the vegetable market in the city of Karlovo,t.km.

Number of vehicles for transporting all the produce from the plantation to the vegetable market n, pcs.

$$n = \frac{M}{K.\xi_1} \qquad (7)$$

where: M – total mass of transported material, t; K – carrying capacity of the transport vehicle, t; ξ_1 – load capacity utilization factor.

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Due to the fact that machines are often overloaded on short distances, ξ_1>1, but in order to comply with the provisions of the road traffic law of the Republic of Bulgaria, ξ_1 =1 is assumed.

In the presence of means of transport with different load capacities, a combination is made. The Load Capacity Utilization Factor ξ_2, % of the means of transport for a given combination is determined.

For its determination, the already calculated number of means of transport is used, and the value is rounded to the next larger integer nr, pcs (when processing data with the EXCEL program product, the ROUNDUP function is used).

$$\xi_2 = \frac{M}{n_r.K}.100, \% \quad (8)$$

With the parameters set in this way, ξ_2>90%.

In case of more than one combination with ξ_2> 90 %, the one with the maximum value is selected.

III. RESULTSANDANALYSIS

The object of the research is the volume of transport operations of 10 plantations (Fig. 3.) with white head cabbage variety "Dabene 5" to the municipal vegetable market. Five plantations are outside the settlement. The remaining 5 are in courtyards in the village.

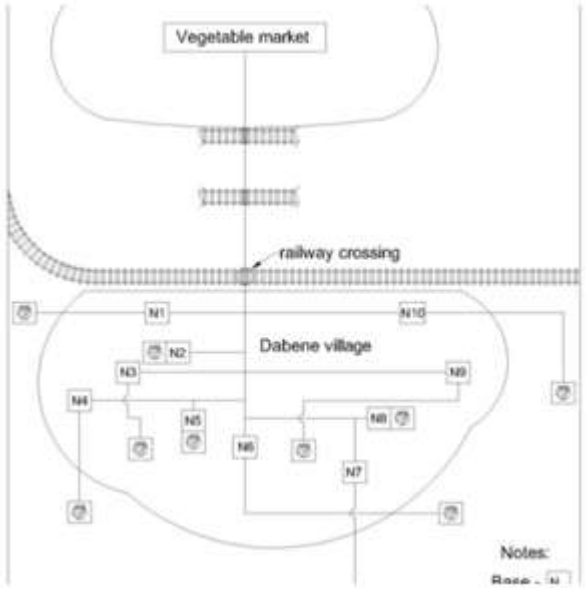

Figure 3. Layout of plantations, bases and vegetable market

Using the timing, measurement and dependencies developed in the MATERIAL AND METHOD section, data were obtained, tabulated and displayed graphically.

Number of cabbages in 1da $\mathbf{n_z}$ = 1194 pcs.

The mass of one cabbage $\mathbf{m_z}$ = 2.97 kg.

The average yield of 1da is 3.55 t.

The value of the mass of 1 cabbage and the average yield are in the lower limits due to two factors:

- The inability of producers to irrigate regularly and sufficiently, mainly due to climate change.
- The lack of nutrition with mineral fertilizers, due to the low capacity of some producers and the high price of fertilizers.

In order to reduce the cost of the survey and the carbon footprint in the atmosphere of the means of transport used in the measurement, it is divided into three parts:

- First part – from the plantation to the owner's base;
- Second part – from the owner's base to the railway crossing at the northern end of the village located on the road to the town of Karlovo;
- Third part – from the railway crossing to the municipal vegetable market.

This division was also necessitated by the fact that the road is the same from the railway crossing to the municipal vegetable market.

The remaining two sections are individual for each plantation.

3 plantations are in the yards where their owner's base is (N2, N5 and N8). The remaining 7 plantations are at some distance. Plantation data are given in the following table:

Table 1. First part of the study

Plantation	Distance from plantation to base L_1, km	Time to travel the distance t_1, h	Speed of movement V_1, km/h
N1	0.50	0.028	18
N2	0	0	0
N3	0.34	0.016	22
N4	0.41	0.026	16
N5	0	0	0
N6	1.12	0.059	19
N7	1.37	0.062	22
N8	0	0	0
N9	0.98	0.041	24
N10	0.93	0.052	18
Average value	0.57	0.0284	13.9

From each base to the northern end of the village (the railway crossing on the road to the town of Karlovo) the time and distance were recorded in three repetitions.

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Table 2. Second part of the study

Plantation	Distance from the base to railway crossing L_2, km	Time to travel the distance t_2, h	Speed of movement V_2, km/h
N1	0.43	0.024	18
N2	0.37	0.011	35
N3	0.82	0.024	34
N4	1.08	0.043	25
N5	0.66	0.024	28
N6	0.58	0.014	41
N7	1.15	0.043	27
N8	1.04	0.036	29
N9	1.26	0.063	20
N10	0.80	0.044	18
Average value	0.819	0.033	27.5

The speed limit in the settlement (Dabene village) is 50 km/h, but due to the fact that only single streets have a new asphalt coating, and the rest are uncoated or the pavement is very old (from the time when the USSR existed), broken (have many potholes) the maximum safe speed is no more than 30 km/h. In some places below 10 km/h. In addition, some routes are entirely in the settlement, while others also have parts in the countryside (the so-called "Sub-Balkan Road"). These facts account for the differences in average speed shown in Tables 1 and 2.

For base N9, it is evident that there is a difference in the speed of movement from the plantation (courtyard) to the base and from the base to the railway crossing. This is due to the different condition of the pavements on the two routes.

Base N6 is located on the main road Karlovo - Voynyagovo, which passes through the village. This road is newly asphalted. This is due to the high speed of traffic to the railway. crossed.

From the railway crossing to the vegetable market, the distance and the time for its journey were measured in four times L_3 = 5.6 km. Of these, L_{3-1} = 3.9 km are on a municipal road outside a populated place with a maximum speed of 90 km/h. The remaining L_{3-2} = 1.7 km are in the town of Karlovo.

In the first section of 3.9 km, there are crossings of 3 railway crossings and 2 turns (one left and one right), which requires a reduction in speed. The flooring is in good condition. The barriers are automatic.

The average speed when passing this section is V_{3-1} = 71 km/h. Of the 8 measurements made (4 each in both directions), only two times it was necessary to wait for a train to pass, average value of the duration t_4 = 4.8 min (0.08).

Time to travel the distance without stopping at a railway crossing t_{3-1} = 0.055 h.

At the second section, there is an intersection with Republic Road I-6, also known as the "Sub-Balkan Road", where the crossing time is 3.6 min (0.06 h). In the remaining sections of the route, the road has priority. The surface of the road with a length of 1.3 km is in good condition and allows movement at a speed of over 40 km/h. In the remaining 0.4 km it is in bad condition (dug out by torrential rains) and the speed is 10 km/h.

The time to pass this section together with the waiting time to cross the main road is t_{3-2} = 0.133 h.

Determining the volume of transport operations from the plantation to the vegetable market Q, t.km.

Table 3. Volume of transport operations

Plantation	Distance from the plantation to the market Lz, km	AreaF_p, da	Amount of cabbageM, t	Volume of transport operations Q_N, t.km
N1	6.53	0.6	2.13	13.91
N2	5.97	0.4	1.42	8.48
N3	6.76	0.8	2.84	19.20
N4	7.09	1.3	4.61	32.69
N5	6.26	1.1	3.90	24.41
N6	7.30	1.5	5.33	38.91
N7	8.12	1.2	4.26	34.59
N8	6.64	0.9	3.19	21.18
N9	7.84	1.6	5.68	44.53
N10	7.33	0.7	2.49	18.25
Average value	6.984	1,01	3.585	25.038

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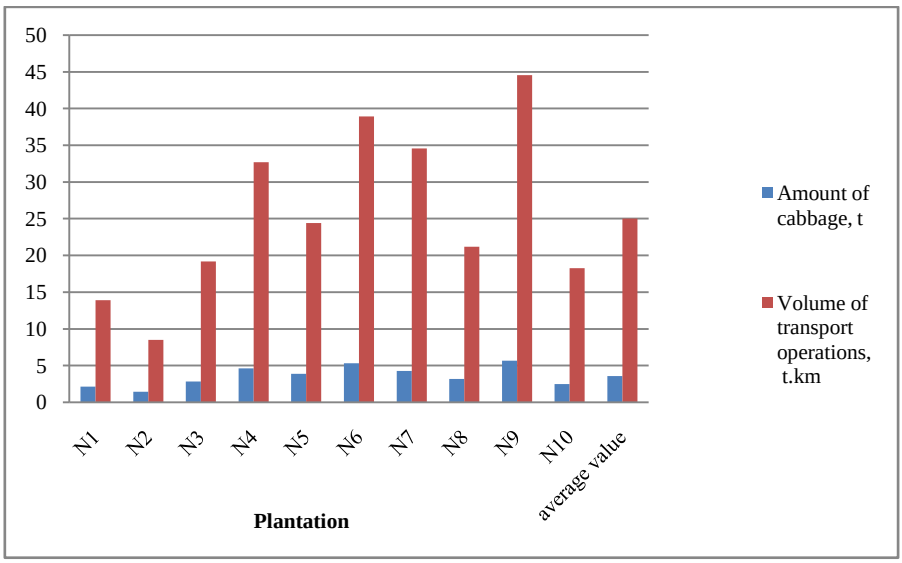

Figure 4. Volume of transport operations and quantity of harvested cabbage

The means of transport used by the local population to transport cabbage are:
- a car with a single-axle trailer, with a total load capacity of K_1 = 0.8 t;
- minivan with single-axle trailer with total load capacity K_2 = 1.2 t;
- minibus with load capacity K_3 = 1.5 t.

Table 4. Number of vehicles to transport all the produce from the plantation to the vegetable market n, pcs

Plantation	Amount ofcabbage M, t	Means of transport		
		K_1 (0.8 t)	K_2 (1.2 t)	K_3 (1.5 t)
N1	2.13	2.66	1.78	1.42
N2	1.42	1.78	1.18	**0.96**
N3	2.84	3.55	2.37	1.89
N4	4.61	5.76	3.84	**3.07**
N5	3.90	4.88	3.25	2.60
N6	5.33	6.66	4.44	3.55
N7	4.26	5.33	3.55	2.84
N8	3.19	**3.99**	2.66	2.13
N9	5.68	7.10	4.73	3.79
N10	2.49	3.11	**2.07**	1.66
Average value	3.585	4.48	2.99	2.39

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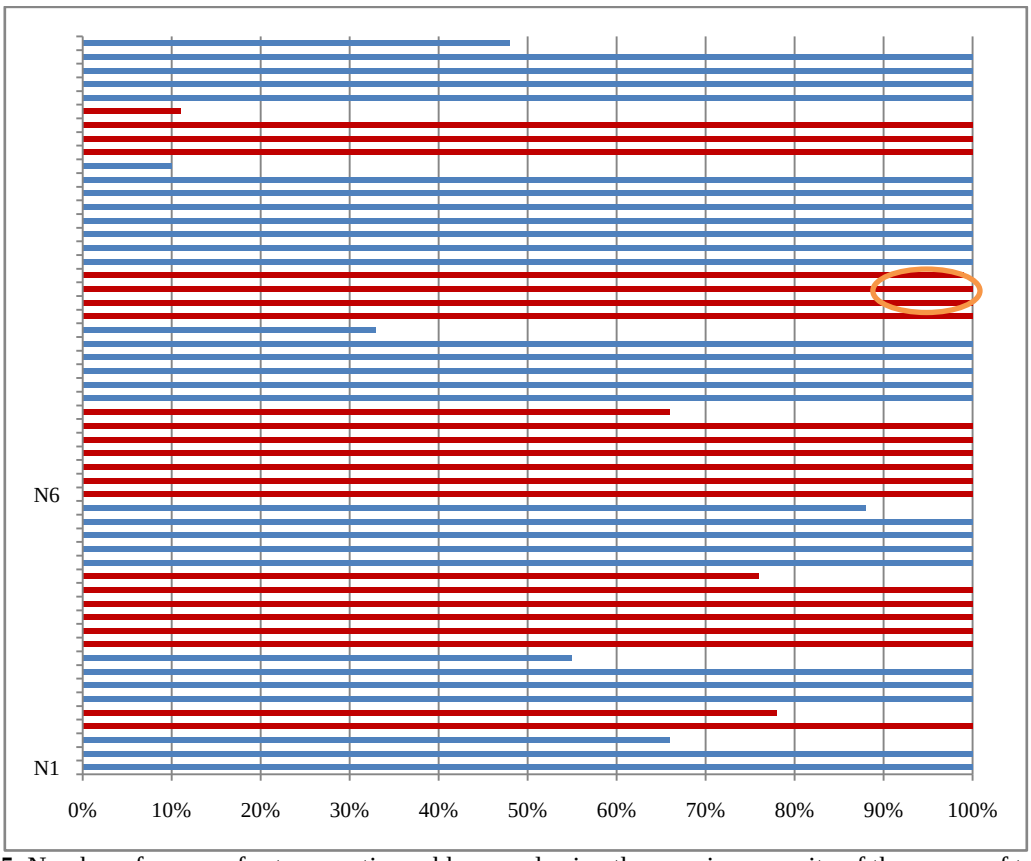

Figure 5. Number of courses for transporting cabbage and using the carrying capacity of the means of transport K_1

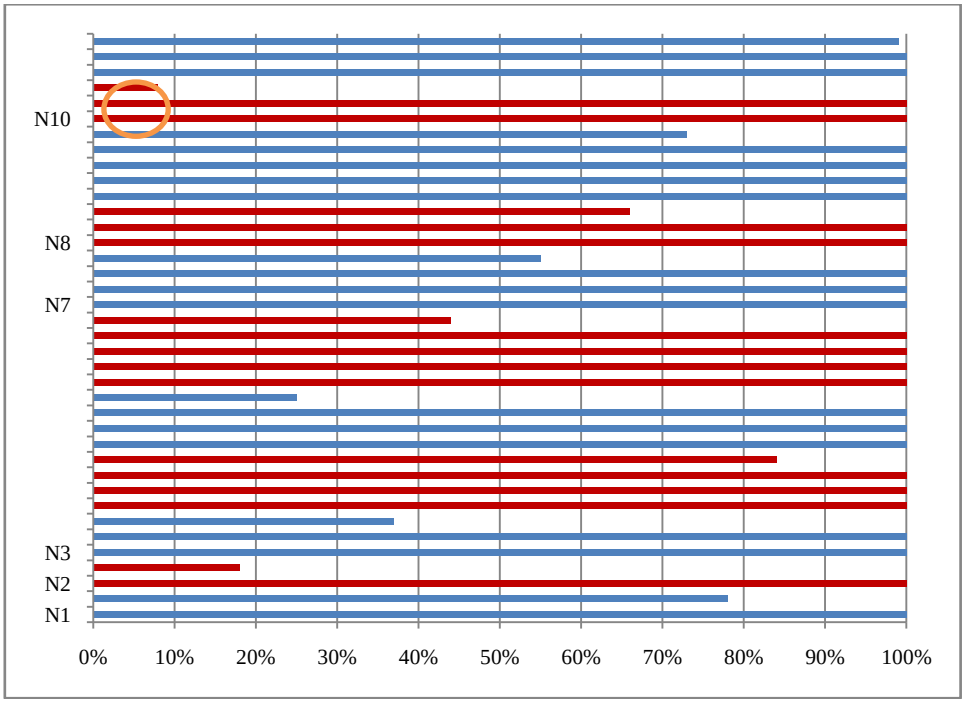

Figure 6. Number of courses for transporting cabbage and using the carrying capacity of the means of transport K_2

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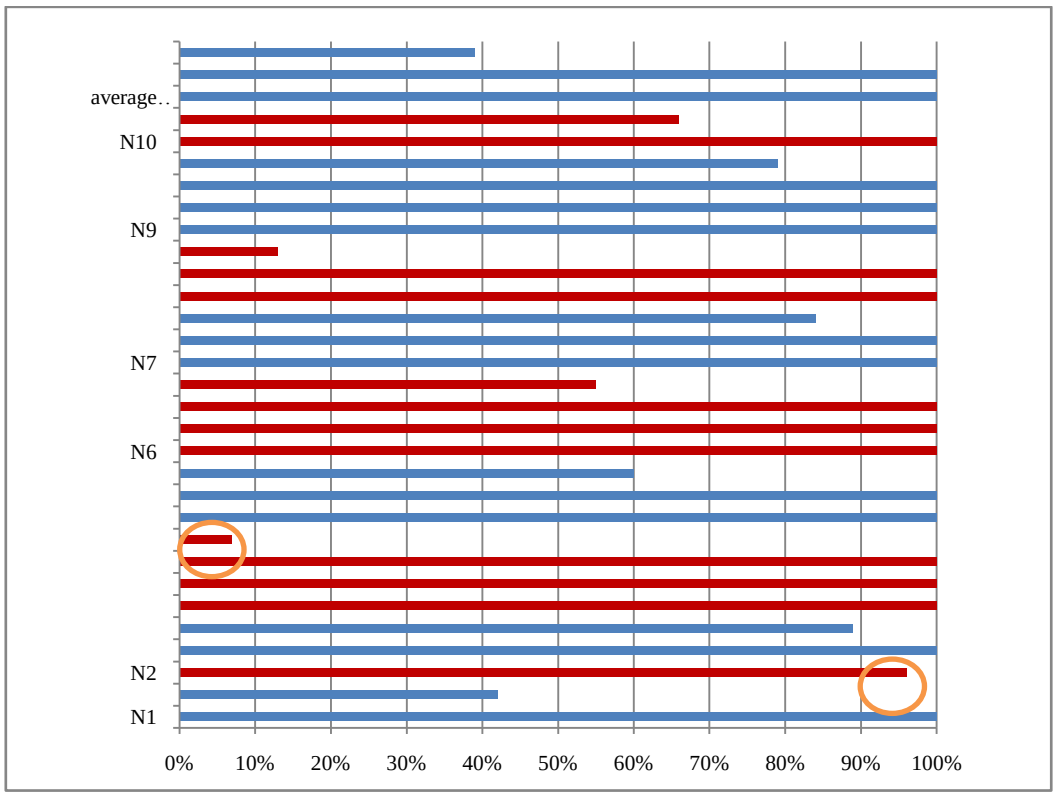

Figure 7. Number of courses for transporting cabbage and using the carrying capacity of the means of transport K_3

From table 4 and graphs fig.5–7 it is clear that in the variants N2-K3, N4-K3, N8-K1 and N10-K2 the carrying capacity of vehicles with overload or underload below 8% of the last course is used. It follows from this that with a correct distribution of the transshipment balance in relation to the performed courses for the transport of the production, this percentage will fall.

For the other options, a combination of the types of transport means K1, K2 or K3 is necessary (table 5).

Table 5. Combination of means of transport in plantations N1, N3, N5, N6, N7 and N9

Plantation	A combination of means of transport	Amount ofcabbage, t	Total carrying capacity of the means of transport, t	Remainder, t
N1	K1+K3	2.13	2.3	-0,17
N3	2.K1+K2	2.84	2.8	0,04
N5	3.K1+K3	3.9	3.9	0
N6	K1+3.K3	5.33	5.3	-0,03
N7	2*K1+K2+K3	4.26	4.3	0,04
N9	K2+3*K3	5.68	5.7	0,02

Table 5 shows that N1 has the largest residue (- 0.17 t). The minus indicates that the full carrying capacity of the means of transport is not used. Such a case exists with N6.

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For N3, N7 and N9, a shortfall in total load capacity of 0.04 t (40 kg) and 0.02 t (20 kg) was observed. This shortage would not create inconvenience due to its small value and the possibility of being distributed among the vehicles participating in the combination.

For the N5 with a combination of vehicles, we have an option with full use of their carrying capacity.

Table 6. Factor of utilization of the carrying capacity of the means of transport ξ_2

Plantation	Means of transport						
	K1	K2	K3	K1+K2	K1+K3	K2+K3	K1+K2+K3
N1	88.75%	88.75%	71.00%	53.25%	**92.61%**	78.89%	60.86%
N2	88.75%	59.17%	**94.67%**	71.00%	61.74%	52.59%	40.57%
N3	88.75%	78.89%	**94.67%**	71.00%	61.74%	52.59%	81.14%
N4	**96.04%**	**96.04%**	76.83%	76.83%	**100.22%**	85.37%	65.86%
N5	**97.50%**	81.25%	86.67%	**97.50%**	84.78%	72.22%	55.71%
N6	**95.18%**	88.83%	88.83%	88.83%	77.25%	**98.70%**	76.14%
N7	88.75%	88.75%	**94.67%**	71.00%	**92.61%**	78.89%	60.86%
N8	**99.69%**	88.61%	70.89%	79.75%	69.35%	59.07%	91.14%
N9	88.75%	**94.67%**	**94.67%**	**94.67%**	82.32%	70.12%	81.14%
N10	77.81%	69.17%	83.00%	62.25%	54.13%	**92.22%**	71.14%

Table 6 shows two things:

- first - there are plantations where the capacity utilization factor is below 90% and it is necessary to calculate new variations of means of transport in different numbers in one combination (Table 7).
- second – at N4- K1+K3 (100.22%), which is an overload. c Due to the small values of the overload of 0.22 % (10.2 kg; 3.4 pieces of cabbage) is not taken into account.

Table 7.A sample of the calculation of the load capacity utilization factor of the means of transport where its value is above 90% for variations with different numbers in one combination

Plantation	Combination of means of transport					
	Factor of utilization of the carrying capacity ξ_2					
N5	2*K1+2*K2	3*K1+K3	2*K2+K3	K2+2*K3	2*K1+K2+K3	
	97.50%	**100.00%**	**100.00%**	92.86%	90.70%	
N6	2*K1+K2	K1+4*K2	4*K1+2*K2	5*K1+K3	3*K1+2*K3	2*K2+2*K3
	95.18%	95.18%	95.18%	96.91%	**98.70%**	**98,70%**
	4*K1+K2+K3	K1+3*K2+K3	2*K1+2*K2+K3	2*K1+K2+2*K3		
	90.34%	90.34%	**96.91%**	91.90%		
N7	4*K1+K2	K1+3*K2	4*K1+K3	2*K1+K2+K3	K1+2*K2+K3	
	96.82%	96.82%	90.64%	**99.07%**	90.64%	
N8	K1+2*K2	K1+K2+K3				
	99.69%	91.14%				
N9	3*K1+3*K2	2*K1+K3	2*K1+3*K3	4*K1+2*K3	4*K2+K3	K2+3*K3
	94.67%	91.61%	93.11%	91.61%	90.16%	**99.65%**
	4*K1+K2+K3	K1+3*K2+K3	3*K1+2*K2+K3	K1+2*K2+2*K3	2*K1+K2+2*K3	
	96.27%	96.27%	90.16%	91.61%	**97.93%**	

Table 7 shows that when combining the load capacity coefficient in N1, N2, N3, N4 and N10 deficiency values 90%.
The N5 reaches a maximum of 100% in two combinations;
N6 retains its value of 98.7%. There are 10 new combinations over 90%;
N7 improves from 94.67% to 99.07%;
N8 retains its maximum value. A backup variant with a lower value of 91.14%appears;
The N9 has 11 new combinations. The maximum value is higher than 4.
In the future cooperation of manufacturers and the use of higher loading vehicles (5-7.5 t), the indicators will improve significantly.
More loading vehicles (up to 21 t) are not applicable due to the short transport distance and the location of this vegetable market-in an urban area with an inappropriate street network gauge for this type of truck.

IV. CONCLUSIONS

On the basis of the above, can be formulating the following conclusions:

In 8 out of 10 plantations, a coefficient of utilization of the total carrying capacity ξ_2> 90 % is obtained in the variant of being used on one of the three means of transport for transporting the cabbage. At N8 it reaches its maximum of 99.69%.

In order to improve the value of the coefficient in other plantations it is necessary to combine the means of transport.

Theoretically, in addition to combining the means of transport, also combining the loads from the plantations would result in even higher coefficient values, but this is an unrealistic assumption due to the fact that they are competitors for customers on the vegetable market.

Judging by the quantity of cabbage, the areas with arrays and distances to the regional vegetable market are sufficient to develop groupage transport with vehicles with greater load capacity.

Due to the condition of the road network, it is not advisable to use the so -called "highway vehicles" intended for asphalt roads and high speeds, such as normal and even increased patency. This is necessary to avoid damage and replacement on the decorative armor and spoilers of the machines, as well as diseases and sinking on the "black roads".

The Republic of Bulgaria is part of the European Union. There are differences in almost all spheres of life in the country attributed to other countries in the Union. It is in the unity in the differences that the success and the continued prosperity of the Old Continent [29] lies, and therefore the preservation of forgotten local traditions, including the cultivation of emblematic varieties for a settlement or region, is of particular importance, which is displaced by "invasive" hybrids and GMO products.

Judging by the taste of the white cabbage "Dabene 5" is needed state assistance in the preservation and development of the variety.

With a good advertising strategy of the mayor's office of the village of Dabene, tourists would be attracted to the country and from abroad, which would lead to an increase in revenue and investment. On the other hand, the recognition of the variety by users.Increasing demand and production to satisfy it.

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