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DEFINING THE POTENTIAL AND TECHNICAL ZONES OF DISTRIBUTION FOR AGRICULTURAL EXPORTS

The article analyses the methodologies used for determining the potential zones of distribution and comes to the conclusion that none of them fits for the logistics systems for agricultural exports, of plant origin in particular. Taking this into consideration, a new approach – the method of circles was suggested for identifying potential distribution zones. At the same time, to determine the potential distribution zones for perishable agricultural products (fruits and berries with the storage period up to 3–10 days) the method of limiting radius was applied for the technical zone of distribution.

Keywords: *logistics; potential distribution zone; technical distribution zone; transporting; perishable products.*

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ВИЗНАЧЕННЯ ПОТЕНЦІЙНОЇ ТА ТЕХНІЧНОЇ ЗОН ЗБУТУ ЕКСПОРТОВАНИХ СІЛЬСЬКОГОСПОДАРСЬКИХ ВАНТАЖІВ

У статті за результатами аналізу методик визначення потенційних зон збуту виявлено, що вони не підходять для логістичних систем експорту сільськогосподарських вантажів рослинного походження. Враховуючи це, запропоновано «метод кіл» для визначення потенційних зон збуту. У той же час при виборі потенційних зон збуту сільськогосподарських товарів, що швидко псуються (фрукти та ягоди, термін зберігання яких – до 3–10 діб), застосовано метод обмежувального радіуса технічної зони збуту.

Ключові слова: *логістика; потенційна зона збуту; технічна зона збуту; перевезення; вантажі, що швидко псуються.*

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ОПРЕДЕЛЕНИЕ ПОТЕНЦИАЛЬНОЙ И ТЕХНИЧЕСКОЙ ЗОН СБЫТА ЭКСПОРТИРУЕМЫХ СЕЛЬСКОХОЗЯЙСТВЕННЫХ ГРУЗОВ

В статье по результатам анализа методик определения потенциальных зон сбыта выявлено, что они не подходят для логистических систем экспорта сельскохозяйственных грузов растительного происхождения. Учитывая вышеуказанное, предложен «метод окружностей» для определении потенциальных зон сбыта. В то же время при выборе потенциальных зон сбыта скоропортящихся сельскохозяйственных товаров (фрукты и ягоды, у которых срок хранения до 3–10 суток) применен метод ограничивающего радиуса технической зоны сбыта.

Ключевые слова: *логистика; потенциальная зона сбыта; техническая зона сбыта; перевозка; скоропортящиеся грузы.*

Problem statement. Potential distribution zone for agricultural exports is one of the key parameters in the logistics systems modelling. At the same time determining the potential distribution zone is of vital importance for engineering of transport & logistics system, including the choice of carriers' types, transport means, vehicles stock and routes options etc.

For obvious reasons, most agricultural products are treated as perishable cargos, thus requiring a special approach to their transportation and logistics. Transportation

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of perishable cargos is usually performed in special containers or in vehicles with refrigerators. At the same time transportation of such products must be limited in time, since non-compliance with time regulation would lead to product spoilage and consequently to commercial losses.

Recent research and publications analysis. Reviewing the works on potential distribution zones, we can observe numerous methodologies on how to determine them (Imanov, 2012, 2013; Novikov, 2000; Chen et al., 2012; Rogers et al., 2012; Griffis et al., 2012). The most widely spread of them are: the method of defining the horizontal radius applying the theorem of sines (Kotikov & Chudakov, 2005) and the method based on the cosine theorem (Tyapukhin, 2004).

Research objectives. From the already mentioned empirical studies it can be seen that the existing methodologies are not applicable for the logistics systems of agricultural products exports. The key reasons for this are that these methodologies do not take into account such factors as freshness and quality of a product, neither the number of days on sale etc. (Imanov, 2013).

Taking these limitations into account, it is expedient to suggest for usage under such conditions the already tested "method of circles".

Key research findings.

The method of circles. The essence of the method of circles is that knowing the approximate price for a product produced at *A* within the distribution zone *R* and taking into account the synergic profitability to calculate the maximal distance from a producer to a consumer.

For the conditions of synergic profitability the following conditions are to be fulfilled:

$$C > Car, \tag{1}$$

where *C* is the price at *R* for 1 t of a product, transporated by one trip; Car is the cost of 1 t of a product, produced at *A* and exported to *R*.

At the same time *Car* is the sum of the following costs:

$$Car = (Ca + Ctr + C\cos + Ctax) \times \delta, \tag{2}$$

where *Ca* is the market value of 1 t of a product at *A*; *Ctr* is the cost of transporting 1 t of a product on the distance of *Lar*; *Ccos* – the sum of customs duties and other taxes during one trip of transporting 1 t of a product; *Ctax* – taxes and other related expenditures per 1 t of a product transported during one trip; δ – the ratio of damages.

The ratio of damages in its turn can be calculated by the following formula:

$$\delta = q / (Tsel \times Vd), \tag{3}$$

where *Tsel* is the number of days the distributed product spent on the market for sale; *Vd* – the forecast on daily sales; *q* – the amount of a product transported at one trip.

While determining potential distribution zones for agricultural products the optimal price at the ratio δ, is equal to 1. If $\delta \geq 1$, then the product would perish and the value of *Car* at *A* would increase. And if $\delta \leq 1$, then due to the fact that the product volume transported at one trip is not optimal, the transport expenditures *Ctr* would also increase, and this would again lead to product costs rise.

If to consider formula (2) for formula (1), then we will get:

$$Cr > (Ca + Ctr + C\cos + Ctax) \times \delta. \quad (4)$$

Thus, the transport costs *Ctr* will be:

$$Ctr < \left(Cr / \delta\right) - Ca - C\cos - Ctax. \quad (5)$$

On the other hand:

$$Ctr = Lar \times p, \quad (6)$$

where *Lar* is the distance or the radius of the distribution zone from a producer located at *A* to a consumer located at *R*; and p is the cost of transportation per 1 t/km.

Basing on the formula (5) we can find the radius of potential distribution zones for *A* by the following:

$$Lra < \left(Cr / p \times \delta\right) - \left(Ca + C\cos + Ctax / p\right). \quad (7)$$

Taking into account that: $\delta = q / Tsel \times Vd$.

Then:

$$Lra < Cr \times Tsel \times Vd / p \times q \_ Ca + C\cos + Ctax / p. \quad (8)$$

However, the radius of potential distribution zones for perishable agricultural products (apricots, peaches, currants, raspberry etc., that is fruits with the storage term between 3 and 10 days) is not limited to the radius of a technical distribution zone.

Technical zone radius means the maximal distance on which a vehicle can get from the initial *A*, and that depends on the forecasted time of transporting and the speed of a vehicle.

The radius of the technical distribution zone can be calculated by the following formula:

$$Ltex = Ttrc \times \upsilon, \quad (9)$$

where *Ltex* is the radius of the technical distribution zone, in km; *Ttrc* is the forecasted time of transporting, in hours; and υ is the running speed of a vehicle on a particular transportation route.

At the same time:

$$Ttrd = Tst - \sum (Tbox, Tlo, T\cos, Tbord, Tsel, Tdel), \quad (10)$$

where *Ttrd* is the forecasted time of one transportation, in days; *Tst* is the term of product storage, also in days; *Tbox* is the time needed for collection, sorting and packing of a product; *Tlo* – the time needed for loading and unloading; *Tcos* – time needed for all customs procedures; *Tbord* – time needed for crossing borders; *Tsel* – the quantity of days the product spend on sale at a market; *Tdel* – the time of delays for various reasons.

In formula (9) the forecasted time of transporting is calculated in hours – *Ttrc*, then in formula (10) the forecasted time of transporting is calculated in days – *Ttrd.*

And if for railway and water transporting the following equation is correct, then for air and auto transporting it cannot be so:

$$Ttrc = 24 \times Ttrd. \quad (11)$$

For example, during the international automobile cargo transportation the European Agreement concerning the Work of Crews of Vehicles Engaged in International Road Transport (AETR) is widely applied. According to the AETR, the daily duration of vehicle driving cannot exceed 9 hours per one driver.

Taking into the account the stated above, for unimodal international automobile cargo transporting the forecasted time of transporting is calculated by the following formula:

$$Ttrc = Ttrd \times Ndr \times 9, \tag{12}$$

where *Ndr* is the number of drivers participating in the transportation process simultaneously.

Under real conditions the radius of potential distribution zones for perishable agricultural products is limited by the radius of the technical distribution zone, and the following condition has to take place:

$$Lra \le Ltex. \tag{13}$$

Therefore, we suggest calculating the radius of potential distribution zones for agricultural products by the following formula:

$$\left\{\begin{array}{l} Lra < (Cr \times Tsel \times Vd)/(p \times q) - (Ca + C\cos + Ctax)/p \\ Lra \le Ttrc \times \upsilon \end{array}\right\}. \tag{14}$$

Conclusions. The radius of potential distribution zones for agricultural products is calculated according to the method of circles and by the formula (8). But this formula is not appropriate for perishable agricultural products (such as fruits and berries), the storage term of which is only 3–10 days.

At the empirical part of the studies we came to the conclusion that the radius of potential distribution zone is limited to the radius of the technical distribution zone.

The radius of the technical distribution zone is calculated by the formula (9).

The author suggests for the modelling of the logistics systems for agricultural exports of plant origin to determine the radius of potential distribution zones applying the formula (14).

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