UDC 664.723 : 631.21

JUSTIFICATION OF CHARACTERISTICS OF RECEIVING UNIT OF GRAIN CLEANING AND DRYING COMPLEXES

ОБОСНОВАНИЕ ХАРАКТЕРИСТИК ПРИЕМНЫХ УСТРОЙСТВ ЗЕРНООЧИСТИТЕЛЬНО-СУШИЛЬНЫХ КОМПЛЕКСОВ

ДӘН ТАЗАЛАУЫШТЫ- КЕПТІРГІШ КЕШЕНДЕРДІҢ СЫНАҚ ҚҰРЫЛҒЫЛАРЫНЫҢ СИПАТТАМАСЫН НЕГІЗДЕУ

G.N. STANKEVICH, A.V. ZARUB*, M.Zh. KIZATOVA***
Г.Н. СТАНКЕВИЧ, А.В. ЗАРУБИН*, М.Ж. КИЗАТОВА***

(*Odessa National Academy of Food Technologies, **Almaty Technological University)
(*Одесса тағам технологиясының ұлттық академиясы, **Алматы технологиялық университеті)
(*Одесская национальная академия пищевых технологий, **Алматинский технологический университет)

Technical and economic model has been developed for justification of the required number of receiving units of grain cleaning and drying complexes to prevent the occurrence of queue of vehicles.

Көлік құралдарының кезекке тұруын болдырмау мақсатында дән - тазалауышты - кептіргіш кешендердің қажетті мөлшердегі сынақ құрылғыларын негіздеу үшін техникалық - экономикалық үлгі жасалды.

Разработана технико-экономическая модель для обоснования необходимого количества приемных устройств зерноочистительно-сушильных комплексов с целью предотвращения возникновения очередей транспортных средств.

Key words: grain cleaning and drying complex, traffic flow, receiving unit, harvesting unit, hauling unit, queueing theory.

Негізгі сөздер: дән тазалауышты - кептіргіш кешен, көлік ағыны, сынақ құрылғысы, жинау агрегаты, көліктік агрегат, жаппай қызмет көрсету теориясы.

Ключевые слова: зерноочистительно-сушильный комплекс, транспортный поток, приемное устройство, уборочный агрегат, транспортный агрегат, теория массового обслуживания.

Introduction

Transportation and unloading of grain material in receiving unit of grain cleaning and drying complexes (GCDC) is a complicated intraproductive system, related to technological field units. The system includes two technologically interrelated production run: receiving and further cleaning of the grain mass. They are united in one infrastructure by means of direct connections. Directly the system includes the transport arriving from the field, receiving unit, engineering and processing equipment. The main integrative property of this system is coherence of work of all subsystems for the general economic result received from realization of grain and also from products of its processing.

When harvesting under the single

technology when all production from the field is supplied to the receiving unit of grain cleaning and drying complexes (GCDC) traffic flow occurs.

The overall flow of vehicles regardless of the consequences of its constituent single thread according to the theorem of A.Ya. Khinichin becomes arbitrarily close to the simplest or stationary Poisson stream [1, 2].

Due to use of heavy-load vehicles in harvest process it is expedient to apply the modernized intake pits with the increased quantity of places of unloading. (receiving units). According to the volume of grain received 40…60 m^3 one receiving unit will be enough [3].

Due to insufficient quantity of places of unloading in the receiving units of grain cleaning and drying complexes there occurs the queue of vehicles that will cause idle time of all harvest and transport line. It is possible to solve this problem by increase in quantity of receiving units that in turn will cause increase in expenses at their construction and operation.

Methods and objects of research

The purpose of the study is justification of the required number of receiving units of grain cleaning and drying complexes.

Results and discussion

For justification of the required number of receiving units of grain cleaning and drying complexes it is expedient to apply objective function based on criteria of package inputs.

$$З(n_{пу}) = З_{э}(n_{пу}) + З_{пр}(n_{пу}) + З_{п}(n_{пу}) \to \min$$

(1)

where $З_э$ - operating costs for the receiving unit, in currency value;

$З_{пр}$ - loses from idle time of cars in the technological line, in currency value;

$З_п$ - crop losses from increase in terms of harvesting, in currency value;

$n_{пу}$ - number of receiving units.

Expenses on operation of the receiving unit of grain cleaning and drying complexes will be defined by a formula

$$З_э(n_{пу}) = \sum_{i=1}^{n} B_{i\,пу}(a + \mu_{то}) \quad , \qquad (2)$$

where $B_{пу}$ – balance price of i receiving unit, in currency value;

α - assignments on depreciation, share/year;

$\mu_{то}$ – assignments on routine and major repairs, share/year;

n – number of receiving units.

Expenses on idle time of harvesting and transporting units will be expressed in the following way

$$З_{пр}(n_{пу}) = (C_{уа}^{пр} + C_{та}^{пр})t(n_{пу})Д_р , \qquad (3)$$

where , – cost of an hour of idle time of harvesting and transporting unit;

$t(n_{пу})$ – idle time of haversters and vehicles during the shift while waiting for transport unloading, hour;

$Д_р$ – duration of harvesting, days.

Idle-time value of harvesting and transporting units with some some assumption can be expressed as

$$П_{у.а} = \frac{B_{у.а}\alpha\gamma}{t_ч} ; \qquad (4)$$

$$П_{у.а} = \frac{B_{т.а}\alpha\gamma}{t_ч} , \qquad (5)$$

where $B_{у.а}$, $B_{т.а}$, – balance price of harvesting and transporting units, in currency value;

γ – share (specific gravity) harvesting (transporting) unit in annual production output;

$t_ч$ – machines operation period on harvesting of grain crops, hour.

Production losses as the result of idle time of technological and transport machines

$$З_п(n_{пу}) = C_п У K_п Q_к Д_р t_р(n_{пу}) , \qquad (6)$$

where $C_п$ – realising value of the product, currency value/hwt;

У – cropping capacity, hwt/ha;

$K_п$ – coefficient of crop losses;

$Q_к$ – combine capacity, ha/hour.

In general, the traffic flow of vehicles from the field during harvest with the properties of homogeneity and ordinariness is probabilistic. To determine the average duration of idle time of the vehicle while waiting for discharge we use queuing theory [4].

Initial data characterizing queuing system is the number of service facilities N (intake pits), number of requirements n (transporting units), arrival rate of one service requirement X (i.e. the number of returns per unit of time). At calculations we consider capacity of the grain cleaning unit and the volume of receiving units equal to the maximum capacity of the harvest and transport line. Hauling time, number of transporting units, time of unloading are determined by a known technique [5, 6].

The intensity of service requirements is defined as the inverse of the one-time service requirements (– unloading time):

$$\mu = \frac{1}{t_{раз}} . \qquad (7)$$

Arrival rate of the one requirement of service is defined as the inverse of the return time requirements (Hauling time of transporting unit)

$$\lambda = \frac{1}{t_{раз}} . \qquad (8)$$

An average number of requests, served by the receiving unit during hauling time

$$p(N) = \frac{\lambda n}{\mu} , \qquad (9)$$

where N is variation ogf the number of receiving units of grain cleaning complex (N>1);

n – number of vehicles (N<n).

An average number of vehicles in the queue, units.:

$$M_0(N) = \frac{\dfrac{p^{N+1}}{NN!(1-p/N)^2}}{\sum_{k=1}^{N}\dfrac{p^k}{k!} + \dfrac{p^{N+1}}{N!(N-p)}}, \qquad (10)$$

average idle time of the vechicle, hour:

$$T_p(N) = \frac{M_0(N)}{\mu}.$$

(11)

Study of criterion function (1) shows that the number of unloading places in the receiving unit of the grain cleaning unit depends on cropping capacity, type of harvesting and transporting units, seasonal load of the grain-harvesting unit, the area of grain crops, capacity of the cornhouse and hauling distances.

The conducted experimental calculations show the increase in loading transport capacity the need for number of receiving units decreases.

Conclusions

Suggested technical and economic model to substantiate the number of receiving units using queuing theory which allows to justify the number of units taking into account idle time of harvesting and transporting lines and damage from crop losses.

LIST OF REFERENCES

1. Bratushkov, N. V. Improvement of machine technology of potatoe production [Text]: synopsis of a thesis. PhD in Technical Sciences/N.V. Bratushkov – M., 1999.-260p.

2. Zhuzhinov, P.I. How to increase productivity of grain-harvesting machines [Text] / P.I. Zhuzhinov, V.T. Selikhov. - Almaty : Kainar, 1977. – P. 128.

3. Gromov, A.G. Stabilization of work of technological systems of postharvest grain processing [Text] : synopsis of a thesis. D in Technical Sciences / A.G. Gromov. – Chelyabinsk, 1986.

4. Korneev, A.A. Korneevka is a variety of wheat rich in fibrin [Text] / A. A. Korneev, A. A. Griaznov. – Kostanay, 2006. – P. 102.

5. Kutepov, B.P. Increase of a technological capability of system "the operator - the harvester" when harvesting grain crops [Text] : synopsis of a thesis. PhD in Technical Sciences / B.P. Kutepov. – Chelyabinsk, 1987.-187p.

6. Selivanov, A. Activities coordination of activities in agricultural industry [Text] / A. Selivanov, V. Lazovskiy // Staff of agricultural industry. – 1975. – No. 1. – P. 92-98.