PROCESS OPTIMIZATION THRESNING RICE

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Abstract: Inclined camera rice combine harvester provides a more even distribution of the weight of rice transported along its perimeter with a preliminary allocation of free seeds of rice hypophyseal fruitful mass. Achieved by reducing the load on the threshing-separating device combine by reducing the thickness of the applied layer of the rice and ensuring a more uniform supply rice hypophyseal mass combine thrasher.

KEYWORDS: RICE HARVEST, TILT CAMERA, MCU COMBINE, ALLOCATION OF BIOMASS.

1. Introduction

The role of the machine-building industry, both in manufacturing and in the economy of Kazakhstan as a whole is increasing every year. At the same time, a key task of the industrial policy of the state is to develop high-tech and export-oriented industries, namely machinery have the necessary capacity and resources to solve this problem. The strategy of technological development of the Republic of Kazakhstan provided to increase grain production to 25 ... 30 mln. tons. Performing tasks can be achieved through the further modernization of agricultural production and rational use of the available technology in the farms.

The above analysis technology of cultivation and harvesting rice in Kazakhstan established the main causes of losses of harvest of rice and the factors affecting its collection of completeness: simultaneity maturing panicles, were killed, and the density of stems; thickness unevenness roller (coefficient of variation 38.5%); different density of packed roll; overload in a tough regime threshing associated with unprepared pile of rice biomass to threshing. This situation determined the need for the development of advanced technology and design threshing rice harvester.

On the basis of the system analysis of objects production line cleaning rice established the need to incorporate additional operations into the process of preparation to the threshing heap of biomass with advanced time-sampling of grain, which increases the separation of grains, reduces the injury, creating a stable operation threshing and separating device combine. Analysis of the levels of exposure of objects on a production line of rice biomass dynamic model and move it possible to assess the uniformity of the roll width to the desired degree of leveling biomass heap before entering the MCU. Presented tilt camera is a new generation (energy efficiency) feeder for transporting the plant matter from the header or the pick-up in the threshing and separating device self-propelled combine harvester. When compared with existing samples tilt cameras for the transportation of plant matter, this development offers significant advantages, among which the main ones: a significant increase in energy efficiency, reduction of the quantity and quality of grain losses during harvesting, and others. Tests feeder in paddy fields showed that it ensures stable reliable operation without overload rice harvester.

Theoretical, methodological and practical results of the studies were used in carrying out research work undergraduates, PhD students and formed the basis for the development of training programs in the preparation of bachelors in technical professions.

2.1. Preconditions and means for resolving the problem

Rice is one of the most valuable food (diet), organic food, and holds a special place in dealing with issues of food security of the country. First, in 2012 rice production in Kazakhstan increased when in 2014, crops accounted for 199,466 hectares, in 2015 - cultivated area amounted to 227, 656, ie, an increase of 28.19 thousand. ha. The concept of agro-industrial complex of Kazakhstan in the future provides the maximum increase in productivity, through innovative operations included in the technology of cultivation and harvesting of rice.

Figure 1 - Diagram of the layout device for aligning biomass rice combine harvester and thrasher rice grain harvester.

A-reaper, B-spacer, C-tilt camera rice combine harvester, 1-inspection cover, 2- the lower shaft, 3-the device for aligning, 4-biomass conveyor.

When separate harvesting reel is removed, and instead of cutting apparatus installed baler. In the selection of the mass of the pick-up roll, picking up the biomass of rice, delivers it to the feeder
housing rice grain combine harvester. The sloping lower chamber (slave) is installed in the drum grooves that provide technological gap between the conveyor 4 and the bottom 2 at the inlet. The direction of movement of the conveyor 4 is set so that the biomass stream moves along the conveyor 4 and the bottom 2. The biomass enters the inclined chamber where it is captured by the conveyor 4 slats and is pulled on the bottom 2. Due to the fact that the bottom 2 is satisfied corrugated shaped surfaces, where the profile of the corrugations 3 on the bottom 2 are arranged to each other by different frequency distances along the length of feeder and the distance between the corrugations 3 of the bottom 2 is formed with greater frequency in the receiving part feeder, and the apex away from the grind, the biomass of rice grain combine harvester, and the distance between the corrugations 3 in the bottom 2 are located to each other different frequency distance along the length of feeder, the distance between the corrugations 3 of the bottom 2 feeder holds more frequency in the receiving part feeder, which provides a sufficient, i.e. a better alignment of the biomass flow over the width of the feeder, ie width on the grind. The corrugations 3 directionally distribute weight across the width of the chamber, rubbing the panicle rice biomass ribbed edges 3 to the edges, and then evenly fed into the mass of rice thrasher combine harvester.

2.2. Solution of the given problem

Stable-quality rice threshing process provides a consistent work flow line combine mechanisms [6]. Available in rice combine harvester’s production line process preparation and threshing consists of tools and devices designed to ensure quality performance of the following operations:
- the collection and transportation of rice biomass;
- uniform flow distribution of biomass for threshing;
- threshing grain with the smallest crushing;
- separation of the maximum number of commodity grain biomass with a minimum of crop losses and energy costs.

It was found that the value of second feed roller threshing rice is one of the key control parameters that have influence on the stability and sustainability of the process of threshing rice combine harvesters. A second feed conditions, characterized by continuous and unstable oscillations in time portions of the biomass, depends on numerous factors.

Subject to a constant rate of movement combine the value of second feed remains approximately constant. However, in reality, the second inning, and change is the sum of an infinite number of oscillations, the micro of various sizes. Investigations revealed that the continuity of the process when the rice combine harvester, are strongly influenced by low frequency vibrations, since they correspond to different values of second filing.

The explanation for this - different periods of maturation and the heterogeneity of the crop in the rice fields. Changing the second feed, depending on the yields shown only at considerable length harvester passage.

The control device [7] drawing - 1, with a certain yield and working width of the combine header, generates the supply of rice biomass, defined by the equation:

\[ q_i = \frac{0.01 B_i \delta_i}{v_i}, \]  \hspace{1cm} (1)

where: \( q_i \) - feed rice combine harvester thresher biomass per time unit, kg / s; \( B_i \) - yield rice \( q_i \) / ha; \( \delta_i \) - cutting bar width, m; \( v_i \) - combine forward speed, m / s; \( v_i \) - the ratio of the mass of grain to the entire biomass entering the thrasher.

Having considered the elementary layer heap of biomass in the section A-A before it enters the feeder and after exposure to the control device in cross-section B-B drawing - 1, define, taking into account the shrinkage of the roll, the second feed \( q_{sp} \), according to the formula (2)

\[ q = \rho b h_{cp2} k_{ep} \delta_T, \]  \hspace{1cm} (2)

where: \( \rho \) – the density of rice stalk weight per unit, kg / m³; \( b \) – the average width of the biomass piles, m; \( h_{cp2} \) – layer thickness at the outlet of the control device m; \( k_{ep} \) - coefficient reflecting the degree of alignment of rice biomass, depending on the profile, number, placement and angle of attack rate of working bodies; \( \delta_T \) – conveyor speed, m/s.

Assume that the flow of piles of biomass and its similarity with the control device implemented uniformly, then equating the right sides of equations (1) and (2) we get:

\[ 0.01 B \delta Q / v = \rho L h_{cp2} k_{ep} \delta_T, \]  \hspace{1cm} (3)

at a certain speed of movement of the conveyor, the thickness of the layer of rice biomass is determined by:

\[ h_{cp2} = \frac{0.01 B \delta Q}{(\rho L k_{ep} \delta_T)}. \]  \hspace{1cm} (4)

Redistribution heap of biomass in the control device takes place in the process of moving it to the threshing drum and the uniformity of a heap of rice biomass threshing drum width is estimated coefficients leveling and shrinkage (figure 1, A-A, b-b) [2]. Uniformity coefficient \( k_{p1} \) heap of biomass at the entrance to the tilt camera is given by

\[ k_{p1} = \sum_{i=1}^{n} \frac{(h_{1i} - h_{cp1})^2}{n - 1}, \]  \hspace{1cm} (5)

and the uniformity coefficient \( k_{p2} \) when leaving piles of biomass of feeder:

\[ k_{p2} = \sum_{i=1}^{n} \frac{(h_{2i} - h_{cp2})^2}{n - 1}, \]  \hspace{1cm} (6)

where \( h_{cp1}, h_{cp2} \) - average thickness of the layer at the entrance (\( h_{cp1} \)) and output (\( h_{cp2} \)) of the feeder house.

In view of the above, the uniformity heap of biomass attained control device in the feeder housing is determined by the alignment factor - \( k_{sp} \):

\[ k_{sp} = \frac{k_{p1} - k_{p2}}{k_{p1}}. \]  \hspace{1cm} (7)

The best quality is achieved by aligning \( k_{sp} \) = 0 or when \( k_{sp} \rightarrow 1 \) and limits \( k_{sp}, 1, \ldots, n \).

The average shrinkage factor \( k_{wc} \) biomass during the passage of it through the feeder is determined by:

\[ k_{wc} = \frac{h_{cp1}}{h_{cp2}}, \]  \hspace{1cm} (8)
For the coordinated work of the production line necessary process control. System control will present the function critical in a changing environment, the following tasks:
- ensuring the sustainability of the process of threshing rice biomass;
- the achievement of a coherent operations of all devices and combine the mechanisms;
- uniform feed to the threshing piles of biomass.

2.3 Results and discussion

To determine the rate leveling biomass rice developed a new method and conducted laboratory tests on an experimental laboratory setting [7.8]. Methods of determining the coefficient of leveling the biomass of rice realize by the device shown in figure 3.

Figure 3 - Schematic of the experimental laboratory setup for the determination of the coefficient of leveling the biomass of rice:
1- conveyor; 2- auger; 3-reel; 4-conveyor feeder; 5- II-shaped measuring frame; 9-discharge conveyor; 10-frame.

The device includes a tilt camera 1, the spacer 2 with a feeder 3 and its conveyor 4 having a movable II-shaped frame 5 with a cutout 6 which is fixed adjustable vertically and moved around the neckline clamp 7 and 8 metric ruler. Also push the cuttings for edge tilt camera 1 is the discharge conveyor 9 with the same moving frame 10. Determination of coefficient biomass leveling rice this device is as follows. In the weighed portion of the biomass of rice through the clamp 7 adjusting its vertical and moving on the frame 6 cutout 5 metric ruler 8 measure the coordinates of the original butt and spicy part different colors of colored stems, along the central axis relative to the tilt camera. Then the rice biomass supply conveyor 4 feeder 3 spacer 2 and tilt camera 1 with the leveling device corrugated type. Having studied and optimized through the working parts of the alignment device tilt camera rice combine harvester, they fall onto the discharge conveyor 9. Here, also by means of the latch 7 adjusting it vertically and moving on neckline 6 frame 5 metric ruler 8 measure the offset coordinates butt spike often colorful colored stalks, relative to the same reference system, and then calculate the average numerical value of the difference between the most and least biased coordinate relevant stalks and evaluate leveling factor biomass of rice according to the formula:

$$
\mu = \frac{\sum x_{\text{max}} - \sum x_{\text{min}}}{\sum x_{\text{max}}} \quad (9)
$$

where:
- $\sum x_{\text{max}}$ - the maximum displacement of colored stems, mm;
- $\sum x_{\text{min}}$ - minimum displacement colored stems, mm; $\mu$ - leveling factor is calculated numerical value of the coefficient of leveling the biomass of rice.

An parametric mathematical models of working parts for feeder rice combine harvester having the form:
- multiple regression equation unfolded for the process indicators leveling biomass rice depending on the angle of attack x1, height x2 frequency and placement of working bodies x4, the feed rate of biomass rice x3:

1. The coefficient of leveling biomass rice $\mu, \%$

$$
\mu = 71,51 + 1,18906 x_1 - 1,49493 - 4,36088 x_2 - 0,66959 + 1,86027 x_3 - 0,90464 + 2,08086 x_4 - 1,67166 + 0,6686 x_2 - 0,25 x_1 x_3 + 1,63912 x_1 x_4 + 2,6675 x_2 x_3 + 1,60656 x_2 x_4 + 0,9175 x_3 x_4 \quad (9)
$$

2. Branch grains from panicles, m,\%

$$
m = 3,75 - 0,4459 x_1 + 0,69893 - 0,35672 x_2 + 0,04502 - 0,18537 x_3 - 0,22008 - 0,02973 x_4 - 0,32612 - 0,26723 x_1 x_2 + 0,3125 x_1 x_3 - 0,46922 x_1 x_4 - 0,2625 x_2 x_3 + 0,3666 x_2 x_4 - 0,3375 x_3 x_4 \quad (10)
$$

3. The extent of damage to the rice seed during threshing, $\Pi, \%$

Where x - the width of the tilt camera; $h_i$ – the thickness of the biomass layer. $x_i = 1,2,3,4,5,6,7,8,9$ - height control point roll. A-A – section at the entrance to the roller control device; B-B – outlet.

Picture 2. Driving leveling and shrinkage heap biomass passing through the inclined combine camera
II = 3,15 – 0,08918 x1 + 0,24856+ 0,53508 x2 + 0,16019 – 0,21766 x3 + 0,19554 – 0,20809 x4 + 0,2839 – 0,27059 x1 x 2+0,0375 x1x3 + 0,07258 x1 x 4 – 0,4625 x2 x 3 – 0,45168 x2 x 4 – 0,0125 x3 x4

(11)

Tests tilt cameras in rice fields (Figure 4) shows, that it provides a stable solid without overloading the work of a combine harvester.


Due to design changes in-line biomass preparation for threshing and technology process in MCY rice combine is conditions controlled resource. The changes helped to stabilize the constancy of the angular speed of the drum, and therefore, significantly reduced the number and size of additional acceleration, providing shock effects on panicle. Timely dealing figure hypophyseal weight to the drum reduced power consumption in its drive to 15%, no doubt a result of the passage of biomass through improved tilt camera, where the bulk of the stems had preliminary deformation. Decreased not thrashing to 6%, 8% fragmentation and microdamages grain to 13%, increase the capacity of MCY to combine 15% [9-11].

2.5. Literature

1. Sadykov J. S. and others. Inclined camera rice combine harvester // Description of the invention to the patent before №19347. KZ. Publ. 15.05.2008, newsletter №5. (in Russian).