Automatization of settings of working organs of technological process of combine harvester

Yuri Tsarev[1,*], *Elena* Adamcikova[1], and *Martin* Najie[1]

[1] Don State Technical University, Gagarin square 1, Rostov-on-Don, 344000, Russia

Abstract. The development of scientific and technological progress is currently in the direction of the introduction of electronic control systems that can help a human being in everyday affairs that does not require special creativity, for example, in unmanned driving, in aviation - the inclusion of an autopilot. The same happens in agricultural machinery. So in the modern harvester uses a system of precision agriculture, however, has reached the introduction of electronic systems that would regulate the optimum process flow of the operations, to take account of changing agricultural conditions on the field. Everything necessary for this purpose in combine harvesters is, it is electric and hydraulic drives that regulate the speed of the combine, the speed of rotation of the reel, the speed of rotation of the threshing unit, the speed of the fan, the amount of opening of the blinds, etc. However, now the combine operator sets it all manually. In the DSTU for several years as a program for on-Board computer (BC) and received a Patent for the invention, allowing to start the implementation of the process setup of the combine in automatic mode, but often the developer is easier to buy something abroad than to design and implement.

The decrease in the manufacturing of local grain combine harvesters which has a consequently lead to the decrease in the acreage for cereals, despite the average increase in productivity and cereal production, due to large losses of cereals, adversely affects the overall food security of the country, which has a population of 150 million people approximately, which should be at least 150 million tons of grains.

Therefore, increasing the productivity of domestic cereal combine harvesters and reducing grain losses is one of the main tasks of the domestic agricultural machine – manufacturing, as the main grain harvesting machines remain combine harvesters [1].

One of the ways to increase the productivity of the combine harvesters and reduce grain losses is the optimal setting of the parameters of the working units of the technological process. More than 80% of the grain fields of Russia have variable soil fertility: up to 100% of the yield of trampled, contamination, moisture content of grain and straw, etc. Manual

* Corresponding author: ycarev@donstu.ru

setting does not provide, due to the constantly changing field of soil fertility, maintenance of technological process at the optimum mode can therefore be shortfalls of performance, unaccounted scrub and broken grain, to increased fuel consumption.

The solution of this problem is seen in the creation of the prerequisites for automation of the adjustment of the parameters of the working bodies of the technological process of combine harvesters in the fields of Russia, in order to increase productivity and reduce grain losses, with the help of an on-Board computer (BC). Here it is impossible to confuse automation (adaptation) settings of working units of technological process with unmanned driving (exact agriculture) of combines on the field [2].

The modern analysis of the state of combine harvesting of grain crops in the country indicates that locally manufactured combine harvesters already use foreign developments and modern technologies that allow the combine through the BC, but again, manually adjust the process to the recommended operating modes (Fig. 1). Moreover, the recommendations for setting up, taken from the outdated "Memo to the combine", which is still specified rpm, instead of s-1, according to the ESKD, because it is easier to combiner.

If in the main grain-producing foreign countries such an approach is explained, since the fields for grain are largely aligned both in yield and in relief, so it is enough to adjust the technological process of the combine harvester before harvesting once. Domestic fields require the combine harvester to constantly adjust the parameters of the working bodies of the technological process, because of the constant change of the agricultural background [4].

The Don State Technical University has developed a program for computers, which allows on the basis of statistical information about the work of combine harvesters to obtain mathematical models of the process of functioning of combines, which without the intervention of a combine harvester could give control effects on the settings of the working units of the technological process in the BC, depending on the changes in the agricultural background [5].

Revealed that the most informative for the analysis of co-upgrading harvesters gives the General statistical reasonable to discuss European civilization abilities of change of key performance indicators, and above all: performance, throughput, loss, crushing, etc., depending on the basic design parameters of harvesters, settings working bodies and their working conditions (soil fertility).

Experimental data can form a multi-dimensional state space, therefore, with the help of computers and modern information technologies based on statistical methods of analysis, due to the constant replenishment of experimental data of databases of the multi-dimensional state space. It can be achieved to take into account the dynamic characteristics of the process of functioning of combines in the form of mathematical models, even with elements of self – learning [6].

The introduction of electronic devices based on BC for automatic control of setting the operating parameters of the process (X), such as:

- the speed of the motion of the combine,
- the rotation speed of the threshing drum and the cleaning fan,
- the regulation of the opening of the gaps, the deck, etc.,
- depending on the changes in the current agro-background Z, contributes to the efficiency of the technological process of the K-Bain (Y), where efficiency is understood as achieving maximum production under restrictions on the loss and crushing of grain.; or with minimal losses of grain, with a limit on the performance and crushing of grain.

VERSATILE ROSTSELMASH

Terminal universal module

Recommended operating modes

culture wheat

c / ha	20	30	40	50	80
km / h	9.0-11.0	8.0-9.0	7.0-8.0	5.0-8.0	3.0-5.0
	current		recommended		
rpm of threshing drum	0		700 - 800		
rpm, fan	0		670 - 750		
mm, the gap at the concave outlet	2		3 - 6		
mm clearance blinds upper sieve	9		12 - 16		
mm, the gap of the upper grid of the extension	9		8 - 14		
mm clearance blinds lower sieve	10		6 - 10		
* It is necessary to stop the harvester, turn on the thresher and set the engine speed more than 1800 rpm			apply *	stop	

setting / culture

O Bob	O oat	O soy
O mustard	O Meadow fescue	O triticale
O pea	O millet	O bean
O buckwheat	O sunflower	O cotton
O Hedgehog team	O wheat	O lentil
O red clover	O Winter wheat	O barley
O castor bean	O Spring wheat	O Winter barley
O hemp	O Ryegrass high	O Spring barley
O corn	O colza	O Other 1
O sesame	O rice	O Other 2
O Lucerne	O rye	O Other 3
O flax	O safflower	O Other 4
O poppy	O The seed sugar beet	
O chickpea	O sorghum	
		cancel

Fig. 1. Module settings for the recommended modes of operation (parameters of working bodies) combine harvesters company “Rostselmash”

In modern conditions, it becomes technically impractical to install a large number of devices in the cabin of the combine. To obtain generalized data on the work of the combine, it is possible to process the initial information using BC, using electronic sensors for monitoring internal parameters of the x setting and external parameters of the agricultural

background Z, which, unfortunately, from the point of view of creating the element base for monitoring the current agricultural background, require its improvement.

If now at the stage of creating a combine harvester enter in BC combine (Fig. 2 [7]) statistical results of work of harvesters-analogue and the program of implementation of the mathematical model.

$$Y = f(Z, X) \tag{1}$$

where: *Y* - performance indicators of the combine: grain productivity (*W*), the loss of the thresher (q_m), the loss of the adapter (q_a), the value of weed impurities in the hopper (*C*), the value of grain crushing (*D*), specific fuel consumption (*T*);
Z - conditions (agricultural background): grain yield (Y), grain moisture (B_3) and straw (B_c), infestation of the field (*Z*), stalks (*P*), grain filling (*U*);
X - parameters (optimization) settings of the processor: the speed of the processor (V), the rotation speed of threshing drum (n_b), fan speed cleaning (n_o), the gap at the inlet (S_e) and the output (S_a) of the threshing machine, the amount of opening of the shutters of the upper (S_o) and lower (S_u) of sieves, etc.,

then, solving the on-Board computer of the combine harvester, the task of optimizing one of the parameters

$$max\ (min): Y = f(Z, X) \tag{2}$$

with limitation on the conditions of the combine process:

$$0 < q_m \leq q_m^d;\ 0 < q_a \leq q_a^d;\ 0 < C \leq C^d;\ 0 < D \leq D^d;\ 0 < \mathrm{T} \leq T^d, \tag{3}$$

by adjusting the parameters of combine optimization:

$$V \subset G_1;\ n_b \subset G_2;\ n_o \subset G_2;\ S_e \subset G_4;\ S_a \subset G_5;\ S_0 \subset G_6;\ S_u \subset G_7 \tag{4}$$

taking into account the conditions of the agricultural field:

$$Y \subset G_8;\ B_3 \subset G_9;\ B_c \subset G_{10};\ Z \subset G_{11};\ P \subset G_{12};\ U \subset G_{12} \tag{5}$$

where $G_1 - G_{12}$ are the permissible control areas of the corresponding parameters, it is possible to maintain in automatic mode without the participation of the combine, for example, the maximum performance of the combine, with the restriction of no loss and crushing of grain.

However, it is easier for a developer to buy something somewhere than to develop and implement him or herself and in fact his developments can be well sold, but no one thinks about it in terms of money and so well lives.

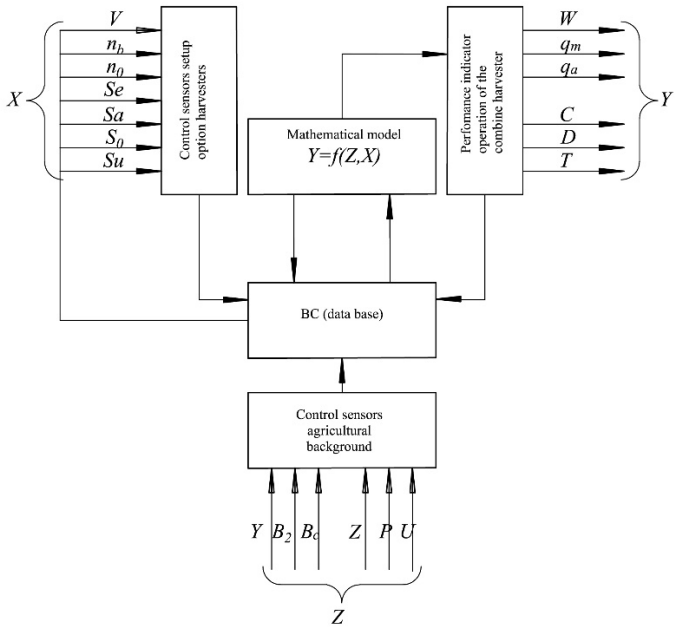

Fig. 2. Combine harvester.

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