Tarasenko, A.P.; Orobinskii, V.I.; Merchalova, M.E.; Buravlev, N.E.
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Revista Ciencias Técnicas Agropecuarias, vol. 24, núm. 2, abril-junio, 2015, pp. 49-52
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Available in: http://www.redalyc.org/articulo.oa?id=93234170008
Innovative ways of improving mechanization of high-quality seeds

Vías innovadoras para mejorar la mecanización de semillas de alta calidad

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ABSTRACT. This paper shows the survey of the results of quality ratings of grain obtained from drum-type and rotary combine harvesters during the winter wheat harvesting. It has been determined that rotary combine harvesters significantly reduce grain damage. With continuous fractional methods of grain postharvest treatment being used, it is possible to simplify the design of seed cleaning machine and to reduce energy and material resources with less grain damage.

Keywords: drum-type and rotary combine harvesters, grain damage, simplification of seed cleaning machine, reduction of the energy and material resources.

RESUMEN. Este artículo muestra los resultados de las clasificaciones de la calidad del grano obtenidos con combinadas cosechadoras con órganos de corte de tipo tambor y rotatorias durante la cosecha de trigo de invierno. Se ha determinado que las cosechadoras de órgano rotatorio reducen significativamente el daño a los granos. Con los métodos de fraccionamiento ininterrumpido de tratamiento poscosecha del grano, se hace posible simplificar el diseño de las máquinas de limpieza de los granos y reducir la energía y los recursos materiales con menos daño del cereal.

Palabras clave: cosechadoras con órganos de corte de tipo tambor y rotatorias, daño a los granos, simplificación de las máquina de limpieza de semillas, reducción de los gastos de energía y recursos materiales.

INTRODUCTION

A key task of agribusiness is a sustainable growth of grain production. The food security of the state is significantly determined by the total harvest of the grain, which is needed for raising seed funds, for providing people with high-quality food products and animal husbandry with grain forage. In order to successfully boost production of the high-quality grain and seeds it is needed to promptly implement new innovative technological and engineering solutions during the harvesting and postharvest treatment (Lachuga et al., 2009; Tarasenko et al., 2013). The main reason for the decrease in the seed germination is the high level of their damage during the harvesting and post-harvest treatment (Pugachev, 1976; GOSAGROPROM, 1988; Aniskin et al., 1992; Pyanykh & Rodimtsev, 2000). Another reason is the “loads” of the unprocessed grains on the trashin floor that are accumulated because of inefficient production of the grain cleaning machinery. In order to get high-quality food grain it is needed to lower grain damage during the harvest and also to organize continuous processing of the grain heap, which is coming from combine harvester. When the coming from the combine harvester grain heap is stacked to the trashiing floor, it is exposed to the weather conditions and microorganisms (Orobinskii, 2006). Moreover it is subjected to additional grain damage for 4...6% during the loading to the grain-loader or throwing over to the grain Thrower. This increases energy and resource spend for the grain production and obtained seeds often do not meet the requirements of GOST (State Standards) (GOST R 52325-2005). For preventing this it is necessary to apply continuous processing of the grain heap especially in the seed-growing farms. This will lessen both the total grain damage and the presence of the most dangerous types of grain damage.

METHODS

In order to impartially appraise the influence of the grain damage on the sowing qualities of seeds, it is necessary to
use the following index of damage $T_{np}$, where the all kinds of damage ages lead to the same situation, where the germ is damaged.

$$T_{np} = G_2 + G_1 \frac{b_1}{b_2} + G_3 \frac{b_3}{b_2} + G_4 \frac{b_4}{b_2} + G_5 \frac{b_5}{b_2} + G_6 \frac{b_6}{b_2}$$

where: $G1...G6$ are the percentage of the grain with the ejected germ, dam aged germ, dam aged coat of germ, dam aged coat of the germ and endosperm, dam aged endosperm, dam aged coat of endosperm; 

$b1...b6$ are the coefficients determined by the formula:

$$b_i = 0.01 (B_i - B)$$

where: $B7$ is the germination of the undamaged grain, %, $Bi$ is the germ ination of the grain with the dam ages under consideration, %.

The multiple year research results demonstrated that the laboratory germ ination of the wheat averaged: without damage 99%, with damages: of the germ 50,8%, of the endosperm 60,6%, of the germ coat 85,6%, of the germ and endosperm coat 83,4%, of the endosperm coat 94,4%.

RESULTS AND DISCUSSION

Nowadays national and foreign companies produce combine harvesters with the drum -type system or rotary trashi ng and separating system. Several foreign companies switched over to the production of the combine harvester only with the rotary trashi ng and separating system.

Both the rotary and drum -type combine harvesters are used in the Central Black Earth Region of Russia, how ever drum -type combine harvesters are prevailing at the present time. The damaged grain, which is arriving to the post harvest treatment in the grain heap, drastically makes it difficult to obtain certified seeds and often high-quality food grain. It has been established that every 10% of the damaged seeds decreases yield capacity of the cereal crops by 1,0… 2,5 dt/ha and the higher the level of the damaged seeds, the greater the reduction of the yield capacity.0 nly due to the high level of the damaged grain annual harvest shortfall it makes up 10… 15 million tons (Erov et al., 2009). The highest dam age of the grain exists during the harvesting. Therefore the most important scientific and production task is to find ways of reducing grain damage during the harvesting period. Talking about Central Black Earth region the drum -type combine harvesters of national and foreign companies are preferably used. Moreover rotary combine harvesters both of foreign companies «New Holland», «John Deere», «Case IH», «Massey Ferguson», «Challenger», «Fendt» and of national «Torum 740» are emerging on the fields in the recent years (Trufyak & Trubilin, 2013; Tarasenko, 2013).

The quality of the grain obtained at the harvesting basically hinges on structural features of the trashi ng and separating system and its operating mode, namely on am outand level of mechanical effect on the grain during the harvesting period.

The survey results of the quality of the wheat grains obtained by drum -type combine harvesters such as «New Holland» 9660, «New Holland» CS 660, «New Holland» CR 9080, «John Deere» 9880 and «Torum 740» are shown in Table 1 below.

A according to the Table 1 the grain heap obtained by rotary combine harvesters contains less crushed and damaged grain.

<table>
<thead>
<tr>
<th>Combine harvester</th>
<th>Type of the trashi ng and separating system</th>
<th>Rotor (drum) speed, min(^{-1})</th>
<th>Grain content in the heap, %</th>
<th>1000-kernel weight, g</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Deere 9880</td>
<td>rotary</td>
<td>700</td>
<td>96,78</td>
<td>0,05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>96,57</td>
<td>0,12</td>
</tr>
<tr>
<td>John Deere 9660</td>
<td>drum -type</td>
<td>700</td>
<td>97,42</td>
<td>0,85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>97,33</td>
<td>1,51</td>
</tr>
<tr>
<td>New Holland CR 9080</td>
<td>rotary</td>
<td>600</td>
<td>96,64</td>
<td>0,08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>700</td>
<td>96,80</td>
<td>0,02</td>
</tr>
<tr>
<td>New Holland CR 9080</td>
<td>drum -type</td>
<td>800</td>
<td>96,64</td>
<td>0,03</td>
</tr>
<tr>
<td>New Holland CS 660</td>
<td>drum -type</td>
<td>600</td>
<td>96,41</td>
<td>0,81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>700</td>
<td>97,00</td>
<td>0,79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>95,98</td>
<td>1,77</td>
</tr>
<tr>
<td>TORUM 740</td>
<td>rotary</td>
<td>700</td>
<td>68,48</td>
<td>0,59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>70,93</td>
<td>0,74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>900</td>
<td>97,73</td>
<td>0,94</td>
</tr>
<tr>
<td>Polesie GS-12</td>
<td>drum -type</td>
<td>820</td>
<td>93,80</td>
<td>3,46</td>
</tr>
</tbody>
</table>

The survey results show that rotational combine harvester «New Holland» CR 9080 causes minimal shattering of grain and grain damage during the wheat harvest.

Moreover rotor speed influences on content of the grain in a glum in the grain heap. Necessary rotor speed should be set just according to the level of the grain in a glum. This index is easily monitored in the field conditions. If the grain heap contains a lot of grain in a glum it is necessary to increase rotor speed. In addition to the above the content of the crushed and damaged grain will increase a little.

The samples obtained from rotational combine harvesters at rotor speed 800 m in\(^{-1}\) practically lack caryoposes with ejected germ. 

Comparing level of shattering and damage of the grain caused by combine harvesters it is important to note that the higher level of the shattering and damage of the grain caused by rotational combine harvester «John Deere» is brought by feed better-acce-
Reducing of the Mechanical Damage during Harvesting and Grain Handling: Recommendations

EROV Y.V., NURULLIN E.G., KARIMOV H.Z., SALAHIEV D.Z.: Holland CS 660 the rotary combine harvesters «New Holland» during the harvesting and especially during the seeds harvesting and during the grain elevator.

Holland CS 660 the rotary combine harvesters «New Holland» CR 9080 boosts shattering of the grain through the increase of amount and level of the mechanical effect on the grain in the crop feeding and damage of the grain through the increase of amount of the grains lock in the combine auger CR 9080, «John Deere» 9880 and «Torum 740» reduce on the average the shattering of the grain in 25,92; 16,85 and 8,68 respectively and the damage of the grain in 1,24; 1,12 and 1,11 times. The results show that change-over to the production of the rotary combine harvesters will reduce damage of the grain during the harvesting. This will allow improving quality of the seeds, to lower seeding rate and to increase yielding capacity.

Influence of the rotor or drum speed on the shattering of the grain caused by rotary and drum-type combine harvesters is described by equations (3) and (4) with enough accuracy, where $D_p$ is the rotary combine harvesters and $D_o$ is the drum-type combine harvesters:

$$D_p = -4,299 + 251,4 \cdot 10^{-4} \pi - 46,64 \cdot 10^{-6} \pi^2 + 0,287 \cdot 10^{-7} \pi^3$$

$$D_o = 3,364 - 0,2406 \cdot 10^{-4} \pi - 24,06 \cdot 10^{-6} \pi^2 + 0,2765 \cdot 10^{-7} \pi^3$$

Damage of the grain caused by rotary $T_{np,p}$ and drum-type $T_{np,o}$ is described by described by equations (5) and (6):

$$T_{np,p} = 16,3 - 43,35 \cdot 10^{-4} \pi + 21,75 \cdot 10^{-6} \pi^2$$

$$T_{np,o} = 20,97 + 0,1302 \cdot 10^{-4} \pi + 13,02 \cdot 10^{-4} \pi^2$$

The studies demonstrated that the use of the rotary combine harvesters allows significant decrease in the damage of the grain during the harvesting and especially during the seeds harvesting. In comparison with drum-type combine harvester «New Holland» CS 660 the rotary combine harvesters «New Holland» CR 9080, «John Deere» 9880 and «Torum 740» reduce on the average the shattering of the grain in 25,92; 16,85 and 8,68 respectively and the damage of the grain in 1,24; 1,12 and 1,11 times. The results show that change-over to the production of the rotary combine harvesters will reduce damage of the grain during the harvesting. This will allow improving quality of the seeds, to lower seeding rate and to increase yielding capacity.

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CONCLUSIONS

- It has been determined that rotary combine harvesters significantly reduce grain damage.
- With continuous fractional methods of grain postharvest treatment being used, it is possible to simplify the design of the seed cleaning machine including costs of the postharvest seed preparations.

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Recibido: 28/05/2013.
Aprobado: 22/09/2014.
Publicado: 28/01/2015.

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