Wheat grain production in the world and its dynamics

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Abstract. The article examines the dynamics of the gross harvest of wheat grain, its yield in the world as a whole, as well as in the context of parts of the world, countries of the world over a 60-year period (1961-2020). It was established that the gross harvest of wheat grain during the study period on a global scale increased more than 3 times - from 247.7 to 755.0 million tons. A steady increase in wheat yield was also established by 0.202 t/ha every 5 years with the world average value in 2016-2020 - 3.48 t/ha. The leading positions in the world in terms of productivity are occupied by Ireland (9.37 t/ha), New Zealand (9.21 t/ha), the Netherlands (8.77 t/ha), and in terms of gross grain harvest - China (133.2 million tons), India (98.6 million tons) and Russia (76.5 million tons).

1 Introduction

Wheat is one of the main food crops for approximately one third of the world's population [1], the source of 20% of consumed protein [2]. Even a small increase in wheat yield or nutritional value has a huge impact on people's lives. The project, called the International Wheat Improvement Research Initiative, was launched in response to concerns about the growth of the world's population, as well as the decrease, albeit slight, in the area under wheat cultivation [3]. The International Maize and Wheat Center (CIMMYT, Mexico) and the International Center for Agricultural Research in the Dry Regions (ICARDA, Syria) have developed the global WHEAT program to improve food security in developing countries. Canada, France, Germany, the UK and the USA have prepared their own programs, and some developing countries have increased investment in wheat research [4].

In the world production of wheat grain, the share of the species Triticum aestivum L. among other representatives of the genus Triticum is 85-90% [1]. About 5% of global wheat grain production comes from the second most common species, Triticum durum Desf. [5, 6].

2 Materials and methods

The material for the research was the official reference data of The Food and Agriculture Organization of the United Nations, FAO [7] on the gross harvest of wheat grain, its yield,
sown area in the world as a whole, as well as in the context of parts of the world, countries of the world according to five-year plans for the period 1961-2020. The calculation of the average values of the analyzed indicators, as well as correlation and regression analysis, were carried out according to the algorithms outlined by B.A. Dospehov, 1985 [8] using the computer program “Microsoft Office Excel 2007”.

3 Results and Discussion

Analysis of official FAO reference data and correlation and regression analysis showed that on a global scale for the period 1961-2020. There is a steady upward trend in the gross yield of wheat grain and its yield (Figure 1).

Fig. 1. Dynamics of gross harvest (million tons), sown area (million hectares) and grain yield (t/ha) of wheat in the world, 1961-2020, according to FAO data [7].

Thus, if the average wheat yield for the first five-year period under consideration (1961-1965) was 1.18 t/ha, then for the last (2016-2020) it was 3.48 t/ha (an increase for each five-year period was 0.202 t/ha). The gross harvest of wheat grain increased more than 3 times - from 247.7 million tons to 755.0 million tons in 1961-1965 and 2016-2020 accordingly (increase over the five years is 43.565 million tons, regression equation y = 43.565x+233.79).

The increase in the gross harvest and yield of wheat grain with a slight decrease in its sown area is the result of an increase in the general agricultural culture in the world. A steady increase in wheat grain yield is observed in all parts of the world (Figure 2).

The highest wheat grain yield in the last analyzed five years (2016-2020) was achieved in Europe - 4.16 t/ha, with the world average level being 3.48 t/ha. Here the greatest increase in wheat yield is noted - 0.265 t/ha for each five-year period (regression equation y = 0.265x+1.1015). Some authors [9, 10] believe that high wheat yields in European countries are accompanied not only by an agrotechnical factor, but also by favorable natural and climatic characteristics of their territories.

The lowest wheat grain yield for the same period was found in Australia - 2.08 t/ha with frequent droughts. The increase in yield is 0.075 t/ha every 5 years (regression equation y = 0.075x+1.0802). The positive dynamics of wheat yield on this continent is ensured mainly by the selection of drought-resistant varieties [11, 12]. In Asia and North America, the average wheat yield for 2016-2010. almost reached the world average level - 3.35 t/ha and 3.34 t/ha, respectively. In South America it is 3.01 t/ha, in Africa – 2.68 t/ha [7].
The leading positions in the world in terms of productivity are occupied mainly by Western European countries (Table 1) with good moisture conditions for growing wheat - Ireland (9.37 t/ha), the Netherlands (8.77 t/ha), Belgium (8.67 t/ha), Great Britain (8.21 t/ha), Denmark (7.43 t/ha), Germany (7.33 t/ha), France (6.64 t/ha), Sweden (6.27 t/ha), Luxembourg (5.76 t/ha).

Table 1. Countries of the world with the highest wheat grain yield, average for 2016-2020, according to FAO [7].

<table>
<thead>
<tr>
<th>A country</th>
<th>Productivity, t/ha</th>
<th>A country</th>
<th>Productivity, t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>9.37</td>
<td>France</td>
<td>6.64</td>
</tr>
<tr>
<td>New Zealand</td>
<td>9.21</td>
<td>Egypt</td>
<td>6.46</td>
</tr>
<tr>
<td>Netherlands</td>
<td>8.77</td>
<td>Zambia</td>
<td>6.27</td>
</tr>
<tr>
<td>Belgium</td>
<td>8.67</td>
<td>Sweden</td>
<td>6.27</td>
</tr>
<tr>
<td>Great Britain</td>
<td>8.21</td>
<td>Chile</td>
<td>5.81</td>
</tr>
<tr>
<td>Denmark</td>
<td>7.43</td>
<td>Luxembourg</td>
<td>5.76</td>
</tr>
<tr>
<td>Germany</td>
<td>7.33</td>
<td>Namibia</td>
<td>5.29</td>
</tr>
<tr>
<td>World</td>
<td>3.48</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the countries of Africa and Asia - Zambia, Namibia, Egypt, high wheat yields (5.29-6.46 t/ha) become possible largely due to irrigation measures [13, 14]. Wheat yields are high in New Zealand - 9.21 t/ha. During the wheat growing season, despite the cost, the crops are irrigated here twice [15]. A relatively high wheat grain yield for the analyzed period was noted in Chile - 5.81 t/ha. Although, here, as in the above countries, moisture is the main limiting factor for further growth in wheat yields. N. Brunel (2013) reports that about 60.0% of its crops are concentrated in the dry areas of the central part of the country [16].

The gross harvest of wheat grain depends on the area it is sown and the yield. Almost 80% of the wheat grain produced in the world (Figure 3) occurs in Europe (34%) and Asia (44%), where the maximum areas of its sowing are concentrated (28 and 45%, respectively,
according to N.N. Zakharova [3]. Europe occupies a leading position in wheat yield among other parts of the world - 4.16 t/ha; in Asia, the average yield is 3.35 t/ha.

![Wheat grain production in the world by parts of the world, average for 2016-2020, million tons; %, according to FAO [7].](image)

Correlation and regression analysis established positive trends in the gross yield of wheat grain in all parts of the world (Figure 4).

![Dynamics of gross wheat grain yield (million tons) in various parts of the world, 1961-2020, according to FAO data [7].](image)

The fastest growth in the gross harvest of wheat grain is observed in Asia – by 26.558 million tons every 5 years (regression equation \( y = 26.558x + 24.283 \)). In Europe, the increase in wheat grain production is 9.0661 million tons over the same period (regression equation \( y = 9.0661x + 131.05 \)).
Among the countries of the world, the leader in wheat grain production is China - on average for 2016-2020. 133.2 million tons (Table 2), which is more than 1/6 of all grain produced in the world (755.0 million tons). The second and third positions are occupied by India and Russia - 98.6 and 76.5 million tons, respectively.

Table 2. Countries of the world with the highest gross wheat grain harvest, average for 2016-2020, according to FAO [7].

<table>
<thead>
<tr>
<th>A country</th>
<th>Gross yield, million tons</th>
<th>A country</th>
<th>Gross yield, million tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>133.2</td>
<td>Pakistan</td>
<td>25.4</td>
</tr>
<tr>
<td>India</td>
<td>98.6</td>
<td>Ukraine</td>
<td>26.4</td>
</tr>
<tr>
<td>Russia</td>
<td>76.5</td>
<td>Germany</td>
<td>22.6</td>
</tr>
<tr>
<td>USA</td>
<td>53.4</td>
<td>Türkiye</td>
<td>20.3</td>
</tr>
<tr>
<td>France</td>
<td>35.6</td>
<td>Argentina</td>
<td>16.9</td>
</tr>
<tr>
<td>Canada</td>
<td>31.6</td>
<td>Great Britain</td>
<td>15.3</td>
</tr>
<tr>
<td>Australia</td>
<td>23.2</td>
<td>Kazakhstan</td>
<td>13.8</td>
</tr>
<tr>
<td>World</td>
<td>755.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The leading countries in terms of gross wheat grain harvest: China, India, Russia, and the USA are also leaders in terms of its sown area - occupying third, first, second and fourth positions, respectively, in the world ranking of countries [3].

According to FAO reporting data, the annual volume of wheat grain exports in the world is at the level of 170 million tons, which is approximately 1/5 of its world production [17]. Many large wheat grain producers export part of their production (Figure 5). According to the Federal Customs Service, their number in 2016-2020. included countries: Russia, USA, Canada, France, Ukraine, Australia, Argentina [18]. Large importers of wheat grain are Egypt (12.0 million tons), Indonesia (10.4 million tons), Algeria (7.9 million tons), Brazil (7.2 million tons), Bangladesh (5.9 million tons).

![Fig. 5. Largest exporters of wheat grain (million tons), 2016-2020.](image)

D. Workman (2020) reports that from 2016 to 2020. world trade in wheat increased by 22.8%, which indicates its dynamic development during the analyzed period [19].
4 Conclusion

Thus, on a global scale, there is a steady increase in the gross production of wheat grain (755.0 million tons) by 43.565 million tons every 5 years. About 80% of the world’s wheat grain production comes from Europe (34%) and Asia (44%). The leading positions in gross grain harvest are occupied by China (133.2 million tons), India (98.6 million tons) and Russia (76.5 million tons). The annual volume of wheat grain exports in the world is at the level of 170 million tons, which is about 1/5 of its gross production. The growth in gross grain harvest is largely due to an increase in wheat yield (3.48 t/ha) by 0.202 t/ha every 5 years. The highest wheat grain yield was achieved in Europe (4.16 t/ha), where there is a fairly rapid rate of reduction in the sown area - by 4 million hectares every 5 years. The leading positions among the countries of the world in terms of productivity are occupied by Ireland (9.37 t/ha), New Zealand (9.21 t/ha), and the Netherlands (8.77 t/ha).

References

8. B. A. Dospehov, Methodology of field experience (with the basics of statistical processing of research results). – 5th ed., add. and processed (Agropromizdat, Moscow, 1985)


