

## STRUCTURAL DEVELOPMENT OF GRAIN PRODUCTION IN THE WORLD'S REGIONS

**Kazimirs Spogis, Linda Silina, Dana Svedere**  
*Department of Entrepreneurship and Management*

### Abstract

The paper includes the research results on structural development processes in grain production in various regions of the world obtained by analysing the structural composition of output of grain crops and assessing the development trends both in Europe and the other regions of the world. The globalised market of agricultural goods impacts, to a great extent, the production of grains, especially its structure, but these markets are mostly impacted by the development of grain production, especially the trends and directions shaping the structure of total output of these crops. The structural differences are observed even among particular agricultural enterprises of one region, and they are determined by strategic production goals, the structure of agricultural industries, as well as the professional capacity of management, and the impact of traditions.

The research aim is to analyse the structure of total output of grain crops and to assess its development trends in Europe, its regions, and other groups of countries in the world. In the research, it was concluded that the total output structure in various European regions is different, with wheat production dominating in North Europe, whereas the proportion of maize production has significantly increased in the other parts of Europe. But in general, the global grain market is mostly impacted by 10 largest grain producing countries, but especially grain production develops in Asian countries, which can make changes in the impact of groups of countries or regions. According to the research, it was concluded that ten largest areas sown with grain crops belong to 3 Asian, 2 North American and 2 European countries, as well as to Australia, Brazil, and Nigeria, however, their areas sown with grains tend to decrease. The qualitative indicators of grain farming, in terms of productivity, also change, which is determined by the progress of genetics, technologies, and other related industries in any researched region.

The qualitative structure of grain products changes in the world's regions. The dominant crop is rice in Asian countries, but the cultivation of maize also sharply increases.

The structure of output of grains is very different in the European regions, and the changes taking place there are very diverse. The share of wheat absolutely dominates in Western, Northern, and Eastern Europe, whereas in Southern Europe wheat has been outweighed by maize over the recent years. In Northern and Eastern Europe, where natural conditions are not appropriate for maize, the share of wheat continues to rise. In Northern Europe, barley is the most popular crop of feed after wheat, however, its share has significantly decreased there. The share of barley in the grain balance sheet substantially shrinks in Eastern and Western Europe, but it is also popular in Southern Europe. The dominating share belongs to maize not only in Southern Europe, but its share increase also in Eastern and Western Europe. In all the European regions oats are popular, but their share shrinks everywhere. Rye, too, is grown in all the European regions, however, in general, it can be regarded as an insignificant product, as its share has decreased almost twice as much even in Eastern Europe, while in the other European regions the share of rye has decreased to 0.6-2.7%. Over the recent 10 years, a hybrid of rye and wheat – triticale – was introduced in small areas. Rice production is slightly progressing in Southern Europe.

### Key words:

Grain crops, production, sown area, total output.

### Introduction

The globalised market of agricultural goods impacts, to a great extent, the output of grains, especially grain farming and its structure. Only governmental interventions in the grain market or other indirect

measures of protectionism can partially protect Latvian farmers from a complete impact of the world's grain market. Therefore, objective and scientifically justified information on the output structure of food grains and seeds, its development trends and paces would

be important for farmers–grain producers and grain processors. Such information is a basis for planning areas of land to be sown, their location, and structure as well as for tackling technological and machinery problems.

The previous studies of the authors, which were conducted over the recent years, indicate that the areas sown with grain crops, their structures, as well as the output structures of grains are very different among Latvia's regions, irrespective of the small territory of the Republic of Latvia, due to natural and technological conditions in its regions. The main differences are determined by edaphic, technological, topographic, as well as economic conditions.

The structural differences are observed even among particular agricultural enterprises of one region, and they are determined by strategic production goals, the structure of agricultural industries, as well as the professional capacity of management, and the impact of traditions.

It is also important to know what's going on both the local and European Union and global grain markets, but these markets are mostly impacted by the development of grain production, especially the trends and directions shaping the structure of total output of these crops.

The assessment of results of previous studies set forth the research aim: to analyse the structure of total output of grain crops and to assess its development trends in Europe, its regions, and other groups of countries in the world.

To achieve the aim, several research tasks are set forth:

- to ascertain the changes in areas sown with grain crops and in total output of grains for the key grain producing countries;
- to analyse the changes in and divergence of yields of grain crops for the world's countries having various development levels of grain farming;
- to investigate the structural changes in total output of grains in the period since 1990 for regions of the world and Europe.

To perform the research tasks, statistical data bases of the UN's Agricultural and Food Organisation (FAO), data of Eurostat and Latvian statistics, as well as the published results of previous studies of the authors were used.

Adequate research methods were applied to perform each research task – analysis of data-arrays and regression, grouping, and the logically constructive method.

L. Siliņa (2006, 2007, 2009) researched the processes of agricultural structural development in a particular territory of Latvia – in Kurzeme; this region was compared to other Latvian regions within the classification of NUTS 2 regions.

Researchers D. Bernatonyte, Z. Simanavičienė (2008) revealed what changes in the foreign agricultural and food market of Lithuania occurred due to its integration process in the European Union.

J. Piecuch (2007) has analysed the development possibilities of the agricultural industry in one of the world's regions – in Portugal which depends on agricultural products very much.

A group of authors under the guidance of A. Sproģis (2008) has made an assessment to ascertain what changes in agriculture are possible taking into consideration the regional specialisation directions.

LLU professor Mihejeva, L. (2008) believes that the competitiveness and management of agricultural enterprises is characterised by a quantity of agricultural commodities produced per hectare, income gained from sales, and an amount of resources consumed in production and on the basis of the above-mentioned, the professor estimated a possible gross margin at various sizes of farms.

### **Areas sown with grain crops and trends of change in the output of grains**

To perform this task, official statistical data on the ten world's largest grain producing countries for a 10 year period, as well as data on the rest 169 countries for the same period were analysed. The data and estimates are presented in Table 1.

The strategy of grain market policy in the world (all crops), according to the areas planted for grain crops, is mainly shaped by four countries – two Asian countries (India and China), one North American country (USA), and Russia.

A special role can be played by the two big Asian countries whose numbers of population are growing and shares in the world's population are very large.

However, the areas planted for grain crops have also stabilised in these countries, and a slight trend of their decrease is observed. It can be related to a need for agricultural land to produce other products, but the grain market processes have a little impact on it.

A significant decrease in the areas planted for grain crops in North America can be impacted by two major factors:

- grain overproduction which exceeds the purchasing power of consumers and grain processors in the world market;
- radical progress in the science of grain production in the USA, which promotes a sharp increase in grain yields, creates favourable preconditions for an increase in the output of grains, while at the same time using smaller areas for grain crops.

A decrease in the area sown with grain crops in Russia is most likely related to political and economic reforms that were implemented in this country in 1990ies. Such a hypothesis is proven by a fact that since the year 2000 the area sown with grain crops has stabilised in Russia, and a slight upward trend is observed.

**Table 1. Areas harvested for grain crops in the world's 10 countries with the largest areas of grain crops, million ha**

Country	Research years					Change against base-year 2006/1994-1996	
	1994-1996	1999-2001	2004	2005	2006	mln. ha	%
India	100	101.6	97.8	99.5	99	-1	99
China	90.1	86.9	79.8	82.1	83.7	-6.4	92.9
USA	62.9	57.4	56.8	56.8	52.9	-10	84.1
Russia	51.1	40.4	40.5	41.2	40.7	-10.4	79.6
Brazil	19.1	17.6	20.4	19.2	18.4	-0.7	96.3
Nigeria	18.1	17.5	17.7	18.3	19.2	1.1	106.1
Australia	14.5	17.3	20.3	19.9	18.3	3.9	126.2
Canada	18.9	17.8	16.2	15.8	15.9	-3	84.1
Indonesia	14.7	15.2	15.3	15.5	15.1	0.4	102.7
Ukraine	12	12.8	14.9	14.2	14.2	2.2	118.3
Total of 10 countries	401.4	384.5	379.2	382.5	377.4	-24	94
Share of these 10 countries in total area sown with grain crops, %	57.7	57	55.9	55.6	55.2	x	x
In the world	695.2	674.5	678.5	687.7	683.2	-12	98.3
Other countries	293.8	290	299.4	305.3	305.8	12	104.1

Source: data of the UN FAO Statistical Yearbook and the authors' estimates

The other six largest grain producing countries represent various continents – South America (Brazil), Africa (Nigeria), North America (Canada), Europe (Ukraine), Asia (Indonesia), and Australia-Oceania (Australia).

One can conclude that all the continents – their largest grain producing countries – take part in forming the world's grain balance sheet.

In total, the areas of these 10 countries planted for grain crops account for the largest share in the world's area sown with grain crops.

However, the real trends, which are shown in Table 1, are also very important: the areas planted for grain crops in these 10 countries are decreasing, besides, the decrease is substantial and continuous over the recent 10 years.

In the other countries, the areas of grain crops increase, but only a half of the decrease in areas of the large countries is offset by it.

As a result, the world's total area sown with grain crops decreases as well. By analysing and assessing estimates presented in Table 2, it was found out whether the decrease in these areas is offset by the increase in crop yields and total output.

**Table 2. Total output of grains (seeds) in the world's 10 largest grain producing countries, mln.tons**

Country	Research years					Change against base-year 2006/1994-1996	
	1994.-1996	1999.- 2001	2004	2005	2006	milj.t	%
China	422.9	420.3	413.2	409.4	444.1	21.9	105
USA	232.1	334.5	389.1	366.5	338.5	15.4	104.8
India	213.6	238	229.8	240	242.9	29.3	113.7
Russia	69.4	67.2	76.2	76.6	76.9	7.5	110.8
Brazil	46.8	50.1	63.9	55.4	59.1	12.3	126.3
France	56.5	63.4	70.5	64.1	61.8	5.3	109.4
Canada	51.5	49.5	50.8	51	48.6	-2.9	94.4
Bangladesh	27.9	37.9	37.8	41.1	44.8	16.9	160.6
Germany	39.4	46.5	51.1	45.9	43.5	4.1	110.4
Vietnam	26.2	33.9	39.6	39.5	39.6	13.4	151.1
Total of 10 countries	1277.3	1341.5	1422	1409.5	1399.2	121.9	109.5
Total in the world	1975.4	2084.8	2279.2	2266.6	2228.1	252.7	112.8
Total in other countries	698.1	743.3	857.2	857.1	828.9	130.8	118.9
Share of other countries	35.3	35.7	37.6	37.8	37.2	x	x

Source: data of the UN FAO Statistical Yearbook and the authors' estimates

As we can see in Table 2, other countries are included among the largest grain producing countries as compared to the list of the countries with largest areas planted

for grain crops. Asian countries absolutely dominate here – not only China and India, but also Bangladesh and Vietnam. A large share belongs to three European

countries (Russia, Germany, France). North America is represented by the same countries – the USA and Canada.

The following conclusions can be drawn from Table 2:

- the world's grain market balance sheet is regulated by 10 largest grain producing countries, the share of which in the total output of grains accounts for almost two thirds;
- in these 10 countries, the output of grains continuously increase on average by 12 million tons a year;
- very fast progress is observed in Asian countries, especially in Vietnam and Bangladesh, where an increase in the output of grains was 50-60% in the recent 10 years;
- a quite substantial increase was also observed in the European countries – Turkey, Germany, and Russia – which are included in this top 10 list;
- progress in the increase in grain production is stronger in the other 170 countries, which can be regarded as a socially very important fact or process, as it ensures better nutrition in developing countries.

By analysing the relative estimates, one can conclude that the share of the other countries slightly increases

**Table 4. Structure of total output of grain in the world's regions in 1990 and 2007, %**

Grain crops	Asia		North America		Europe		South America		Other regions	
	1990	2007	1990	2007	1990	2007	1990	2007	1990	2007
Wheat	23.8	25.6	29	16.4	49	49.3	25.6	17.4	32.1	26
Maize	15.5	19.7	56.8	74.2	11.5	18.7	48.5	62.2	27.3	27.3
Rice	56.1	54.7	1.9	1.9	-	-	20.4	16.4	10.6	12.2
Barley	2.4	-	6.2	3.4	26	21.5	-	-	10.1	7.1
Oats	-	-	2.1	1.3	5.8	4.1	-	-	2.3	1
Rye	-	-	-	-	7.7	3.5	-	-	-	-
Triticale	-	-	-	-	-	2.8	-	-	-	-
Sorghum	-2.2	-	4	2.7	-	-	5.5	3.9	9.9	16.4
Millet	-	-	-	-	-	-	-	-	7.7	10

Source: data of the UN FAO Statistical Yearbook and the authors' estimates

These changes have to be taken into consideration by European farmers, as maize will continue and increase pressure on grain prices in the world market. On the other hand, relatively cheap feed made of maize can increase meat production, which, in its turn, would provide better nutrition in the world.

- Rice is the main food in Asia, while in South America it is outweighed by maize.
- Barley is the second major component in the grain balance sheet in Europe, but its share shrinks due to the impact of maize. The share of barley also shrinks in Eastern Asia and Oceania.

- The small share of oats has become even less significant in the grain balance sheet, although healthy foods can be made of oats.
- Rye is a specific crop produced only in Europe; it is preferred for making bread, but its share has shrunk twice as much in this region.
- Sorghum and millet are important components of food balance sheet for population in the African continent.

The structural changes of grain farming in Europe are shown in Table 5.

**Table 5. Structure of total output of grain in European regions in 1990 and 2007, %**

Grain crops	Europe		Eastern Europe		Northern Europe		Southern Europe		Western Europe	
	1990	2007	1990	2007	1990	2007	1990	2007	1990	2007
Wheat	49	49.3	49.8	51.2	46.9	54.4	38.3	32	52.7	52.5
Barley	26	21.5	24.2	18.7	40.5	33.3	21.1	23.4	26.5	19.5
Maize	11.5	18.7	8.5	16.2	-	-	32.1	38.9	12.8	19
Oats	5.8	4.1	6.8	5	10	8.7	2.1	0.4	3.3	2.8
Rye	7.7	3.5	10.7	5.4	2.5	1.9	2.6	0.6	4.7	2.7
Triticale	-	2.8	-	3.5	-	1.7	-	0.3	-	3.5
Rice	-	-	-	-	-	-	3.7	4.4	-	-

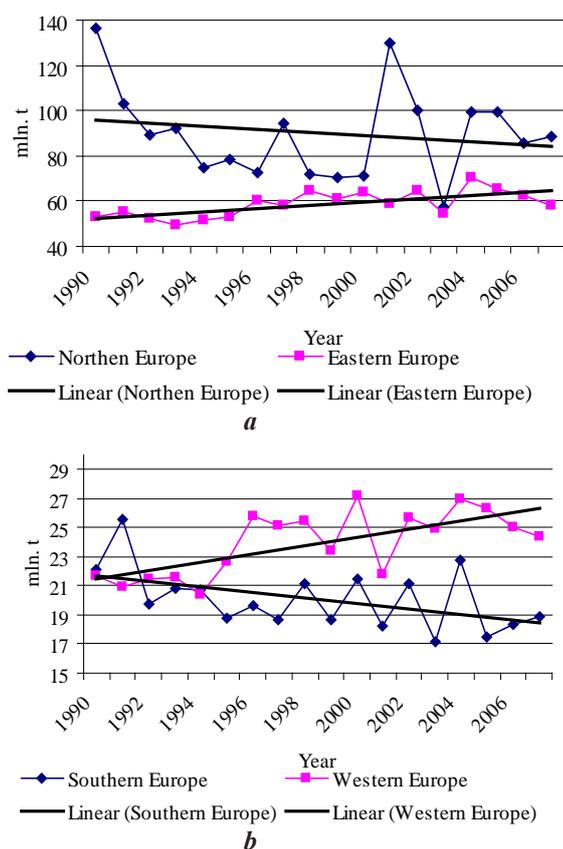
Source: data of the UN FAO Statistical Yearbook and the authors' estimates

A general conclusion made from the results presented in Table 5 is that the structure of output of grains is very different in the European regions, and the changes taking place there are very diverse.

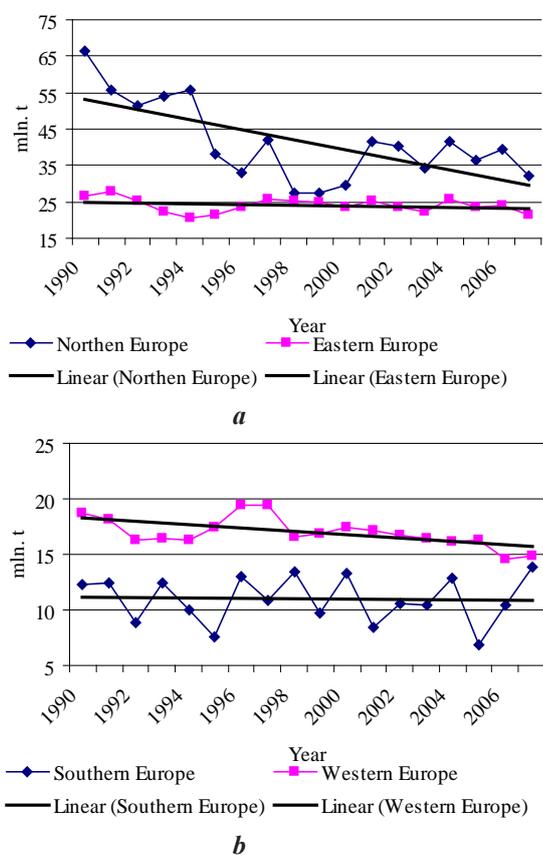
- The share of wheat absolutely dominates in Western, Northern, and Eastern Europe, whereas in Southern Europe wheat has been outweighed by maize over the recent years. In Northern and Eastern Europe, where natural conditions are not appropriate for maize, the share of wheat continues to rise.
- In Northern Europe, barley is the most popular crop of feed after wheat, however, its share has significantly decreased there. The share of barley in the grain balance sheet substantially shrinks in Eastern and Western Europe, but it is also popular in Southern Europe.
- The dominating share belongs to maize not only in Southern Europe, but its share increase also in

Eastern and Western Europe.

- In all the European regions oats are popular, but their share shrinks everywhere.
- Rye, too, is grown in all the European regions, however, in general, it can be regarded as an insignificant product, as its share has decreased almost twice as much even in Eastern Europe, while in the other European regions the share of rye has decreased to 0.6-2.7%.
- Over the recent 10 years, a hybrid of rye and wheat – triticale – was introduced in small areas. Rice production is slightly progressing in Southern Europe. By analysing the most popular grain crops (wheat and barley), one can see that the annual grain balances are very volatile, which depends on several the above-mentioned factors (direct and indirect) (see Figures 1 and 2).



**Figure 1. Development Dynamics of Wheat Production in Europe (1990-2007), mln. t.**



**Figure 2. Development Dynamics of Barley production in Europe (1990-2007), mln. t**  
(a – in Northern Europe and Eastern Europe;  
b – in Southern Europe and Western Europe)

That two figures demonstrate the claims above.

## Conclusions

1. The ten largest areas harvested for grain crops belong to 3 Asian, 2 North American and 2 European countries, as well as to Australia, Brazil, and Nigeria, but their areas sown with grains tend to decrease, although still exceeding half of the total area planted for grain crops in the world.
2. Among the ten largest grain producers, there are four Asian (China, India, Bangladesh, Vietnam), two North American (USA and Canada), and three European (Russia, Germany, France) countries, as well as Brazil (South America). They produce almost two thirds of the world's total output of grain.
3. The grain market can be mostly impacted by the ten largest grain producing nations, but their policies and strategies for grain farming are different. The output of grain increases very fast in Asian countries as well as in several other nations. It can really change the impact of groups of countries or regions on the grain market.
4. Qualitative indicators of grain farming, in terms of productivity, change, which characterises the progress of genetics, technology, and other related sciences in the country. An average yield in the USA has exceeded a rate of  $6 \text{ t ha}^{-1}$  and in China -  $5 \text{ t ha}^{-1}$ .
5. The quantitative structure of output of grains radically changes in the world's regions: in Asia, rice is mostly produced, while the share of maize increases fast; in North America, already three quarters of the total output is maize; in South America, too, rice and wheat areas are substituted by maize; in Europe wheat dominates constantly.
6. The structure of output of grains changes in the European regions: the dominance of wheat increases in Northern Europe, whereas the share of maize substantially increases in Eastern, Southern, and Western Europe. The production of rye disappears in all the European regions, and the share of oats shrinks significantly.

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