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Global production of biofuels in the context of food security

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COMPETITIVENESS OF THE POLISH FOOD ECONOMY UNDER THE CONDITIONS OF GLOBALIZATION AND EUROPEAN INTEGRATION

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This publication was prepared as a contribution to the research on the following subject **Monitoring of agri-food markets under changing economic conditions** within the framework of the research task
Monitoring and assessment of changes on global agricultural markets.

The main objective of the study is the issue of global production of biofuels in the context of food security

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Introduction

Quick growth in production of biofuels, which took place in the last decade, causes concerns among numerous experts worldwide regarding hazards for sustainable development and food security. The production of biofuels constitutes a growing competition for the production of food. It is directly reflected in limiting the area of cultivations for the production of food and fodder for farm animals. Global reports on biofuels indicate that their mass production will result in the growth in crop prices and thus in the growth in farmers' incomes, but it may also result in damage to the natural environment despite benefits resulting from the reduction in the emission of greenhouse gases.

The presented study is the second report analysing changes, which took place in recent years, in the global production of biofuels (bioethanol and biodiesel) as compared to changes in the global production, consumption and trade in cereals and oilseeds which are basic raw materials used in production of biofuels of the first generation. The issues of food security are also presented in the context of the production of biofuels. The report consists of five chapters discussing the following issues:

- chapter 1 presents the contemporary approach to the issue of food security and interactions between the production of biofuels and the global prices of food,
- chapter 2 discusses changes in the global production, consumption and trade in basic raw materials for the production of biofuels: cereals, oilseeds and vegetable oils,
- chapter 3 analyses changes in the global production and trade in liquid biofuels: bioethanol and biodiesel,
- chapters 4 and 5 present the impact of the production of biofuels on the market of cereals and oilseed raw materials.

These parts of the report are supplemented with an ending which contains the main conclusions. It is emphasized that biofuels of the first generation, generating an additional demand for agricultural raw materials, have an undeniable impact on the level of their prices, particularly in years of poorer crops. Thus, when looking for balance between future energy challenges and maintaining food security, it is necessary to aim at the development of biofuels of further generations (from non-food raw materials).

The basis for the presented analyses regarding the global market of raw materials for the production of biofuels was mostly statistical data published by the USDA, while statistical materials published by the FAO and F.O. Licht was used, above all, when analysing the global market of biofuels. Other available sources that were used include data from the World Bank.

The report also uses a number of pieces of information and opinions published in economic and economic-agricultural literature, regarding the interrelations between the market of biofuels and food security on the global scale (the global perspective).

The study is an attempt to take a comprehensive and multifaceted look at problems of the global production of biofuels in the context of the production of bioenergy and food security.

1. Production of biofuels and food security – competition and correlations

Biofuels of the first generation are produced from agricultural products, so far intended mostly for food and fodder. Thus, it is commonly believed that they compete with the production of food. It is assumed that this competition negatively affects the prices of food and thus contributes to deepening the phenomenon of famine in the world. In 2006-2008, the production of biofuels was mentioned as one of the basic factors causing food crises. Only recent years brought numerous analyses [Baffes J. & A. Dennis 2013; Oladosu & Msangi (review of literature) 2013] assigning to biofuels a smaller than previously role in the negative impact on the prices of agricultural products. There are more and more opinions that food crises in the past decade were the result of an entire complex of numerous interactions between the determinants of food markets affecting the growth in food prices and people's welfare. Biofuels were only one of the elements of this complex of correlations.

According to forecasts [FAO 2012], the use of bioenergy, including biofuels, will increase in the future. The interest in biofuels results from the need to maintain energy security, climate change and the growing prices of fossil fuels. For this reason, we should expect changes in the attitude towards the relation biofuels-production of food and the search for a balance between energy challenges in the future and maintaining food security.

1.1. Contemporary approach to food security

1.1.1. Supply and demand for food in the development of economic thought

For many years food security was treated as a degree of self-sufficiency, namely the possibility to satisfy food needs on one's own in a permanent manner. It was usually an element of economic security – people thought that the access to income solves the problem of food security. The liberalization of trade and the growth in the production of food on the global scale made it possible for countries with unfavourable conditions for the development of agriculture to purchase necessary quantities of food on the global markets. Thus, it was not own production but the income which determined the access to food. It was not until the food crisis in 2006-2008 that this approach changed and discussions on various aspects of food security started again.

Taking into account the development of economic thought, we may be under the impression that the present debate on food security is nothing new. It is part of a discussion on the demographic problems of our planet and resulting consequences for the welfare of the human population which has lasted for several hundred years. Food belongs to the category of basic needs. According to the hierarchy of needs by A. Maslow, which organizes needs from the most basic ones (resulting from life functions) to higher-level needs, activated only after lower-level needs are satisfied, food is located at the bottom of the pyramid of needs. Therefore, the growing human population always raised concerns that the supply of food will not equal its demand.

The theoretical grounds for the analysis of this phenomenon should be mostly looked for in the 1798 static theory of resources by Th.R. Malthus. This theory was based on a thesis borrowed from G. Botero (1588) that the human species, with a permanent reproductive capacity, shows an uncontrollable tendency to multiply (increase in number), and on the law of decreasing revenues in agriculture, formulated in the first version by A.R. Turgot (1768) and then by Malthus himself and D. Ricardo. Following the suggestions of other researchers (e.g. B. Franklin) and based on the statistics from the USA and other countries, Malthus stated that the growing number of people alongside a permanent (limited) supply of land may result in the decrease in labour productivity in agriculture. In this situation, agricultural production will not be able to catch up with the growth in the number of people, the supply of food will decrease and the number of people will drop as a result of famine to the level at which it will be possible to ensure an adequate amount of food. Thus, according to Malthus, with the lack of limitations, the human population will increase in a geometrical progression, while the supply of food will grow in the arithmetic progression [Landreth H., D.C. Colander 2005].

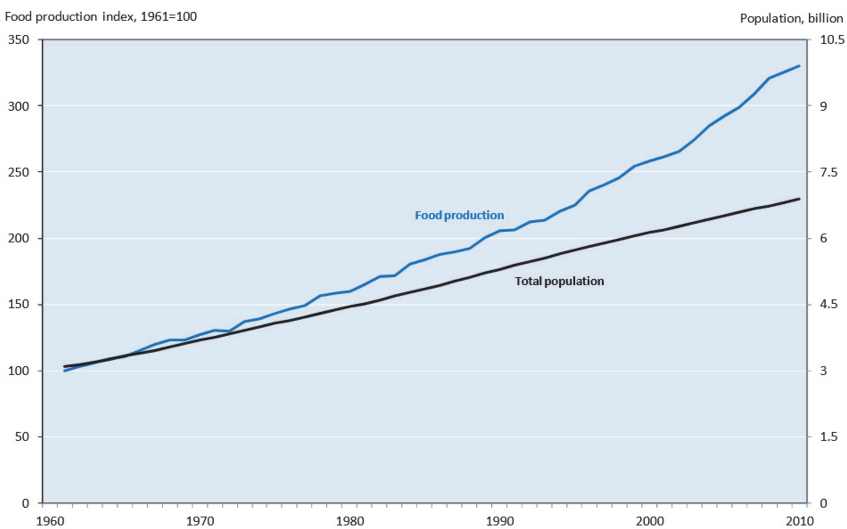
The authenticity of the assumptions of the population theory by Malthus, as well as the school of Malthusianism resulting from it, were questioned quite early on. Malthus underestimated the role of technical progress in the growth in revenues from land and labour productivity. It was as early as the first half of the 19th century that it was proven (H. Passy), on the basis of the experience of various countries, that the progress of agricultural production may take place much faster than Malthus assumed. It soon also turned out that the increase in the number of people does not need to proceed at a constant pace, especially one reaching 3% annually, despite the lack of positive checks. In the second half of the 19th century fertility and birth rate began to significantly decrease in a growing number of countries. This took place to a large extent regardless of the introduction or the failure to introduce preventive checks [PWN Biznes 2013].

Despite these charges, the school of Malthusianism flourished in the inter-war period of the 20th century (K. Wicksell, W.S. Thompson, F. Notestein and others) and especially in the first dozen or so years after World War II. This was related to the so-called population explosion in colonial countries and countries gaining independence. It was feared, at that time, that “the excessive” increase in the number of people could pose a hazard for the possibilities of survival not only for the societies of developing countries but also for the entire mankind. In *The population bomb,* published in 1968, P.R. Ehrlich forecasted that an international demographic disaster combined with famine would take place within approx. 15 years from the book’s publication. In 1972, a report by the Club of Rome, *The limits to growth,* appeared which assumed the exhaustion of our planet’s capacity to maintain the estimated population within approx. 100 years. In 1981, on the other hand, the US President Jimmy Carter ordered a report *Global 2000 Report to the President, 1980.* The report’s conclusions stated that if current trends were kept, the world in 2000 would be “more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now”. Thus, the school of Malthusianism, relating to disproportions and deficits resulting from excessive reproduction as well as inadequate soil fertility, and consequently inadequate supply of food, was enriched as part of Neo-Malthusianism with new elements, namely hazards for mankind resulting from scarcity of resources as well as the increase in pollution of the natural environment.

Malthus’s theory and Neo-Malthusian theories derived from it met with numerous polemics. N. Borlaug, believed to be the father of “the green revolution” in India, questioned Malthus’s theory stating that the present famine was caused by wars, ignorance and poor management. Malthus’s theory is also denied by “the Boserupian model” by E. Boserup, according to which the increase in the number of people is, in fact, a factor stimulating economic, civilization and cultural progress. According to Boserup, the production of food, due to innovations and technological progress, grows faster than the number of people and that is why a Malthusian disaster will never take place. A similar point of view was presented by J. Simon – the author of the ultimate resource theory, dealing with the issues of the population and natural resources. According to him, the principles of demand and supply operate on the basis of a natural mechanism which prevents rapid crises in the availability of natural resources (food, raw materials), while human intelligence makes humanity less and less dependent on non-renewable raw materials. According to Simon, the reduction in the resources of any raw material stimulates the growth in its price and this, in turn, becomes a stimulus for the search for new resources of this raw material (e.g. the acquisition of oil from deeper and deeper deposits) or for innovations resulting in its replacement with something else (e.g. wood or metal – plastics or composites) [Simon 1998].

On the basis of this short review of the development of economic thought, we may be under the impression that the present debate on food security originates in Neo-Malthusianism. The depletion of natural resources is treated as a basic factor limiting the further development of mankind in the future. In this context, much is said about the decreasing supply of agricultural land and, as a consequence, about the decreasing production of food in the world. Statistical data proves otherwise [OECD 2012]. It shows that the production of food on the global scale is intensively increasing and the growth in the human population is moderate (Fig. 1.1). The quantity of food per capita increased by 20% within the last 50 years. Physical access to food is thus not a problem, taking into account the global scale.

Figure 1.1. Global production of food and human population in 1960-2010



Source: Global food security: Challenges for the food and agricultural system, OECD, 28 February, 2012.

1.1.2. Evolution of the notion and indicators of food security measure

As opposed to the supply and demand for food, analysed by economists for many years, the notion of food security is quite new. Despite this, its understanding is still evolving due to changes taking place in the world. The first references to food security in its present sense appeared in 1943 in the USA when the representatives of 44 governments met and took the freedom in access to food *(Freedom from want*) as their objective. The first definition was formulated in 1974 during the World Food Conference summoned because of the global crisis caused by high oil prices in 1973 and the resulting growth in food prices. This definition focused on the supply side of food, particularly on the need to provide access to food and stable prices for basic food products at the global and national levels. In 1981, A.K. Sen extended food security by further elements emphasizing the fact that food may be generally accessible but not everyone may be able to buy it. Taking this fact into account, FAO presented a new definition in 1983 according to which food security was considered as access, both physical and economic, for all people, at any time, to basic food they need. Then in the 1990s the aspect of the nutritional value of consumed food became significant in food security. An adequate quantity of food does not mean that the diet contains a sufficient level of vitamins and microelements. The pressure was thus shifted from the diet's energy value to the content of nutritional components in food. In addition, it was believed that the access to food should be connected with relevant sanitary conditions as well as with the possibility to use clean water ensuring a healthy and active life. Such a wide approach to food security was developed during the World Food Summit in 1996. On this basis, FAO adopted another version of the definition of food security in 1998 stating that food security is when all people, at any time, have physical and economic access to food which is safe, in terms of health, and contains an optimum quantity of nutritional components, satisfies nutritional needs and preferences enabling an active and healthy lifestyle [Pieters and co-authors, 2012].

Such a wide understanding of food security made it necessary to take into account four levels in the analysis of this notion:

- physical access (*food availability*) – when an adequate quantity of food of a given quality is ensured, delivered by the national agricultural production or import, including food aid. The availability of arable land and the effectiveness of the agricultural sector play an important role in ensuring these conditions,
- economic access (*food access*) – guaranteeing the possibility to purchase food for individuals meeting their food needs. Consumer income as well as

prices of food products and other goods and services are significant in this case,
- the degree of use (*food utilization*) – reflects the ability to effectively use food, making it possible to satisfy nutritional needs, access to clean water as well as adequate sanitary conditions and health care,
- stability (*food stability*) – refers to previously mentioned levels as well as their duration. In this context, shocks (temporary character) and periodical events (chronic character) are usually distinguished.

In 2009, during the World Summit on Food Security, the definition of food security was additionally supplemented with social aspects. It was stated that, as a result of prevailing cultural and social standards, people may have no food security guaranteed even if they have access to food in economic terms.

The multidimensional nature of the notion of food security causes significant difficulties in its assessment. Information about its numerous aspects is necessary: what is the present situation and the evolution, causes of changes, potential actions and their efficiency, monitoring as well as evaluation of these actions in order to assess the efficiency of incurred costs and to determine priorities for the future. A variety of indicators are used to obtain such information at the level of the individual, the farm, the state, the region or the world. A comprehensive review of the indicators of food security measure was made in the work by Pangaribowo and co-authors [2013]. It should be mentioned that, according to the authors of this review, the currently used indicators fail to reflect the essence of the measured phenomenon sufficiently because they do not analyse it on all levels referred to previously. Their defect is the fact that they do not distinguish factors affecting food security in the short-term and long-term perspective. It is thus necessary to search for new solutions which will enable a higher efficiency of undertaken political actions.

An example of the indicators of food security measure treated in a comprehensive manner is the Global Food Security Index covering physical and economic access to food as well as the quality, and hygienic and sanitary safety of food [EIU 2013]. Table 1.1. presents the ranking of countries in terms of their food security depending on the level of obtained income.

Table 1.1. Ranking of examined countries in terms of their food security (according to the Global Food Security Index) depending on the level of obtained income*

Income											
high (USD 12,476 per capita or more)			average high (USD 4,036-12,475 per capita)			average low (USD 1,026-4,035 per capita)			low (USD 1,025 per capita or less)		
1	USA	86.8	1	Chile	70.3	1	Ukraine	58.0	1	Burma	40.1
2	Norway	86.5	2	Brazil	67.0	2	Paraguay	52.9	2	Uganda	38.3
3	France	83.7	3	Mexico	66.2	3	Egypt	51.7	3	Kenya	36.4
4	Austria	83.4	4	Uruguay	65.3	4	Morocco	49.4	4	Bangladesh	35.3
=5	Switzerland	83.2	5	Romania	65.0	=5	Sri Lanka	48.6	5	Tajikistan	34.2
=5	Netherlands	83.2	6	Malaysia	64.5	=5	Vietnam	48.6	6	Nepal	33.8
7	Belgium	82.4	7	Argentina	63.8	7	Honduras	48.4	7	Benin	33.7
8	Canada	82.1	8	Costa Rica	63.7	8	Salvador	47.5	8	Guinea	32.0
9	New Zealand	82.0	9	Turkey	62.9	9	Philippines	46.9	9	Cambodia	31.3
10	Denmark	81.8	10	South Africa	61.0	10	Bolivia	46.2	10	Ethiopia	31.2

26	Poland	69.9

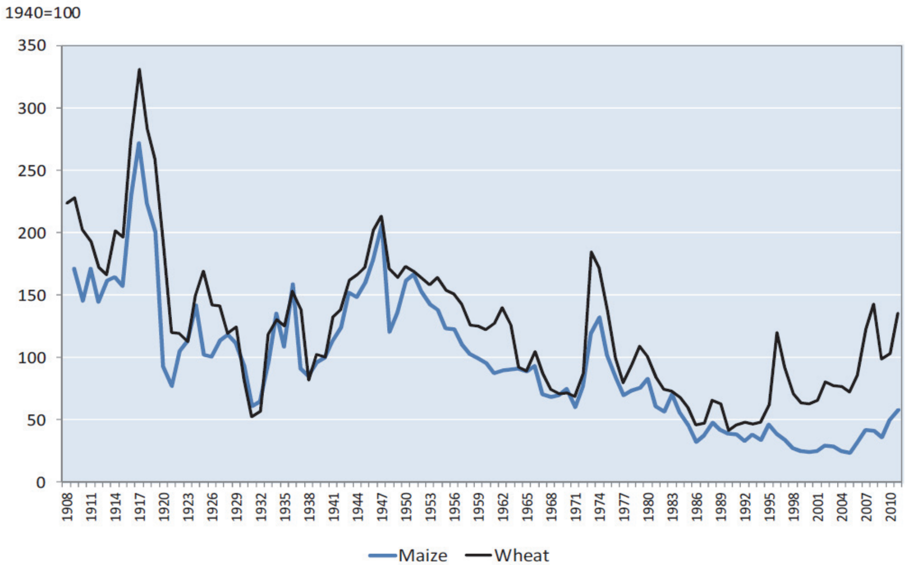
* maximum number of points = 100.

Source: Global food security index 2013. An annual measure of the state of global food security, The Economist Intelligence Unit, 2013.

1.1.3. Food security in national strategies

Some experts question whether we actually experienced a food crisis in 2006-2008 [Headey D. 2011; Swinnen & Squicciarini]. According to them, numerous factors were at play then and the experts simplified the prevailing situation too drastically. The episode of recent sudden growths in food prices is not extraordinary, higher fluctuations of prices occurred during the two World Wars as well as during the fuel crisis in the 1970s (Fig. 1.2). What is interesting, according to FAO even before the crisis of 2006-2008 the prices of agricultural products, which were too low, affected the food security of millions of poor people – mostly farmers from developing countries. On the other hand, when the prices of food grew, the fact that the farmers' income increased as a result thereof was omitted. The situation of poor consumers forced to pay more when buying food was stressed instead. The opinions above should be mentioned to demonstrate the complexity of food security and to indicate the need to analyse it in various dimensions to avoid hasty conclusions. All changes taking place in the contemporary world create both winners and losers, also among poor countries and societies.

Figure 1.2. Index of actual maize and wheat prices in the USA in 1908-2012



Source: Global food security: Challenges for the food and agricultural system, OECD, 28 February, 2012.

There is much evidence to indicate that food security depends, above all, on adequate system and institutional solutions in the political, economic and social sphere. The contemporary world has sufficient production resources of land, labour and capital as well as an adequate knowledge and technological solutions to eliminate famine. One fifth of the population suffers from famine, but one fifth consumes too much food which results in obesity [Ahmad 2011]. It is not enough to produce more food to eliminate famine in the world.

Most countries usually adapt one of the three following policies to ensure food security:

– *food self-reliance* – the production of a given country focuses mainly on the export of agricultural products with the use of comparative advantages, which makes it possible to generate adequate financial resources for the purchase of necessary agricultural products from import,
– *food self-sufficiency* – a given country produces food for its own needs by itself. The difference between the previous approach and the discussed one consists in the growth in agricultural production as the basis, without the import of necessary products. As a result of the last economic crisis numerous countries acknowledged self-sufficiency as one of the key priorities

despite the lack of comparative advantages in the production of basic food products,

– *food sovereignty* – this notion goes outside the notion of food security because, just like self-sufficiency, it relates mostly to the access to food (does not include the origin of products or the production methods), sovereignty stresses not only the access to food but also the origin of this food. In the case of sovereignty, not only the right to food but also the right to the production of food is significant. The ideological approach of this strategy of action was significantly developed by Via Campesina – an international movement associating small agricultural farms and their families [Pieters and co-authors 2012].

From the point of view of global efficiency, a strategy based on food self-reliance seems to be the best for respective countries to ensure food security, but with the assumption that their markets operate in a free and perfect manner. Then, each country may produce the type of food which gives it comparative advantages. However, markets do not operate perfectly and thus depending on global markets is risky. Not only the intervention policy of other countries but also weather shocks, natural disasters or diseases may cause the variability of food prices and a food crisis in a given country. Consequences may vary, depending on whether the country is a net exporter or importer. Export facilitates achieving the payment balance in the national budget but uncertainty, related to the fluctuation of prices of agricultural products, may negatively affect investments and reduce the use of the production potential. On the other hand, in the case of importers, price shocks result in additional pressure on currency exchange rates and, as a consequence, the lack of foreign exchange reserves. The introduction of tax instruments in this situation reduces the negative effects of the crisis but increases budget costs which then need to be satisfied by government loans or discipline in public finance [FAO 2011].

Effects of the variability of food prices also affect households, while this effect varies depending on whether they are consumers or net food producers. Unwealthy farms in developing countries are often consumers which spend most of their income on food. In the case of a food crisis, they focus less on the quality and diversity of consumed food, and they limit its quantity in the next stage. Some countries introduce short-term solutions in trade policy in order to counteract these negative effects. Food exporters try to protect their market by restricting or even stopping export. On the other hand, importers try to reduce the growth in national prices by temporary repeal of tariffs, other import restrictions or the growth in import subsidies. When numerous countries simultaneously protect their own markets by instruments limiting trade, food prices are usually more varied and food security on the global scale is disturbed [Martin & Anderson 2012].

1.2. Interactions between production of biofuels and global prices of food

The market is a key economic category describing the process leading to a mutual agreement through prices of the buyers' decisions regarding the consumption of alternative goods, enterprises' decisions regarding production, and employees' decisions regarding how much and for whom to work, [Kowalski 2007]. The market is thus a set of mechanisms enabling contact between consumers and producers. In institutional economics the market is understood as an institution which coordinates exchange transactions between social entities.

The market is a very wide notion and may be discussed from three basic perspectives: subjective, objective and spatial. From the subjective perspective, these are exchange relations between independent market participants representing the consumers (demand) and the producers (supply). The subjective criterion makes it possible to distinguish the following types of markets: sales, wholesale, retail [Jasiński 1997]. The number of market participants on the side of supply and demand determines its structure (e.g. polypoly, oligopoly, monopoly, oligopsony, monopsony, etc.). From the objective perspective, the market may be examined as a system of supply-demand relations. In this context, markets of goods, services, labour as well as financial and capital markets are differentiated. Depending on the level of detail in conducted analyses, we may distinguish the market of particular products or groups of products. The spatial analysis focuses on the range of the market's impact: local, regional, national, foreign, global [Mynarski 1993]. In the age of strengthening processes of regional integration and globalization, local and national markets become elements of the global market – the concept of the global village [Szymański 2002]. As a result, the impact of changes in the economic situation on external markets is more and more visible on internal markets.

The market mechanism in economic life solves three basic problems: what to produce, for whom to produce and how to produce [Samuelson 2004]. Thus, four functions are attributed to the market: information, profit-making, efficiency and balancing function. On the basis of information about the results of the market game, business entities make decisions regarding current activities as well as regarding investment projects which will enable an effective and competitive functioning in the future. Market information and skilful reading of signals coming from the market have become important elements of building competitive advantages. The market is treated by the participants as an instrument for multiplying income. Effective and competitive market entities win the rivalry and take over the economic surplus but, at the same time, some market participants suffer losses. Market competition forces participants to apply efficient management which is understood as possibly the most beneficial relation between effects and expenditures. The market mechanism verifies the efficiency of management by entities. The balancing function of the market is understood as the ability to automatically restore the balance between demand and supply with the use of prices. Depending on the market structure and its spatial range, a number of other factors stabilizing and destabilizing the entire system (e.g. intervention policy) may have an effect on the equilibrium.

Prices on the global market of agricultural and food products grew in 2004-2005. For 25 years, these prices were low or were characterized by small *volatility* [Figiel 2012]. In subsequent years an upward trend became expressly visible. High prices of agricultural raw materials resulted in a significant increase in food prices and, as a consequence, in a decreased availability of food. The economic barrier of access to food limits food security in states (regions) which are characterized by deficits of food as well as low incomes of consumers [Prakash 2011]. A basic question arises: *What are the reasons for the growth in prices of agricultural products and food?* Another question, maybe even more useful and current, is: *How long will food prices be high and what is their impact on food security?*

It may certainly be stated that there is no single reason for high prices on the market of agricultural and food products. The growth in food prices resulted from the cumulative impact of numerous factors of a very diverse nature: demographic, economic, sociological and environmental. The main factors determining the level of prices in market economics are relations between supply and demand. The growing global demand for food under conditions of small flexibility of agricultural production (in a short-term period) is indisputably the basic factor stimulating the growth in prices. The growth in demand is the result of a dynamically growing number of people as well as the improving income situation in developing countries. The number of people in the world increased in 2000-2013 from 6,118 million to 7,186 million[1]. The growth in the number of people took place on the majority of continents: North America (27%), Africa (26%), Oceania (23%), South America (18%) and Asia (13%) The growth in the number of people in respective regions was caused by various factors. Emigration played the key role in North America and Oceania, while the population

[1] International Date Base. U.S. Department of Commerce. The U.S. Census Bureau.

growth was crucial in Africa and Asia. Only Europe experienced an exceptional situation because its population decreased by 0.4%.

The growth in the global demand and changes in its structure are, apart from demographic factors, the result of numerous changes of economic and social nature. The growth in the number of people was accompanied by a clear economic growth in developing countries (e.g. Asia)[2]. The industry and urbanization processes experienced a huge progress as a result of globalization processes and direct foreign investments of transnational companies in developing countries. The consequence of these changes was the growth in disposable income, which made it possible to increase and change the structure (e.g. an increase in the share of animal protein) and the model of food consumption (*westernization of diets*) [Pingali 2007].

During the vegetation period agricultural production strongly depends on weather conditions. Global climate change leads to more and more frequent unfavourable weather anomalies (draughts, floods, typhoons, etc.) which negatively affect crops and harvest and, as a consequence, the supply of food products. The high decrease in supply from major exporters may result in the growth in prices on the international market.

Energy prices are directly reflected in the prices of agricultural products and food by expenditures (e.g. mineral fertilizers, mechanization, transport). An additional factor strengthening in recent years the correlation presented above was the growing consumption of agricultural raw materials for the production of biofuels. This process was stimulated by the energy and agricultural policies in the United States, Brazil and the European Union.

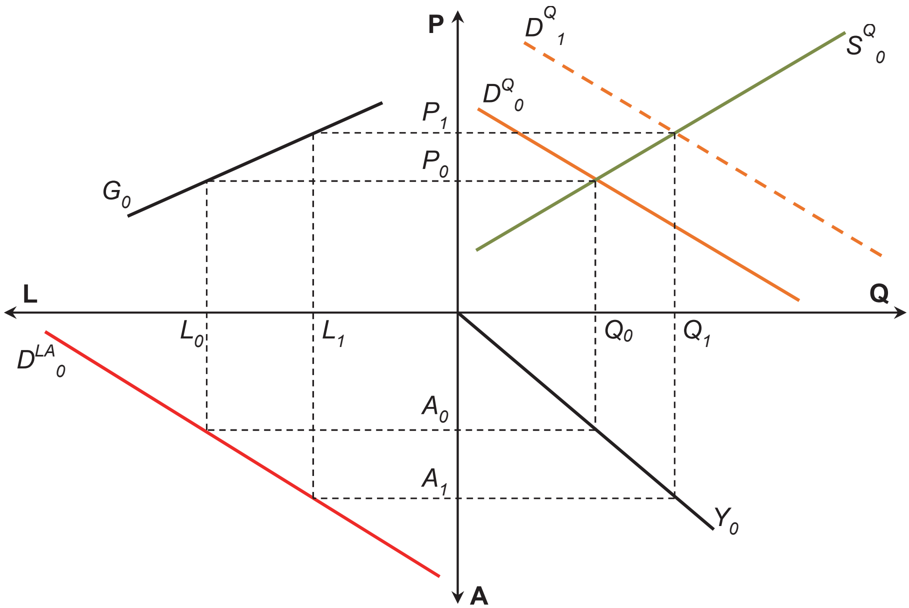
Because of progress in the field of IT and telecommunication technologies the capital became the most mobile production factor [Szymański 2002]. Vast capital resources may quickly move between the most distant regions of the world. High prices of food became a convenient opportunity for vast resources of free capital, including speculative capital, to enter the game on international commodity exchanges [Szajner 2012].

The consumption of agricultural raw materials for the production of biofuels generates an increased demand for cereals, oilseeds and sugar cane. The growth in demand involves a number of economic and environmental

[2] According to data from the World Bank, the Gross National Income (GNI), expressed in Purchasing Power Parity (PPP) per capita, increased in 2000-2012: in Brazil from USD 6,820 to USD 10,150, in China from USD 2,340 to USD 6,810 and in India from USD 1,530 to USD 3,840.

consequences which are visible not only on the agricultural and food market. The growth in demand may be presented graphically as shift in the line of demand function from location D^{Q}_{0} to D^{Q}_{1} (Fig. 1.3). The production and supply of the majority of agricultural products S^{Q}_{0} in a short-term period are characterized by small flexibility which is determined, first of all, by long production cycles as well as limited resources of the land factor. The growth in demand under conditions of a relatively smaller increase in supply determines a new point of market equilibrium. As a consequence, prices grow from the level P_0 to P_1. Increased demand under conditions of specific productivity of the land factor Y_0 results in a greater demand for agricultural land, which may be presented graphically as a shift from point A_0 to A_1. The increasing demand for land in agriculture D^{LA}_{0} reduces its resources from L_0 to L_1 which are used in sectors of the economy. The simple model presented above may be presented in other versions of determining the market equilibrium (e.g. simultaneous shift in the curves of demand and supply). However, this does not change the fact that the effects of producing biofuels from agricultural raw materials and an increase in the expenditures of the land factor are visible in the entire economy. The relation between the prices of agricultural products and the availability of land resources for non-agricultural purposes is graphically presented by the line G_0.

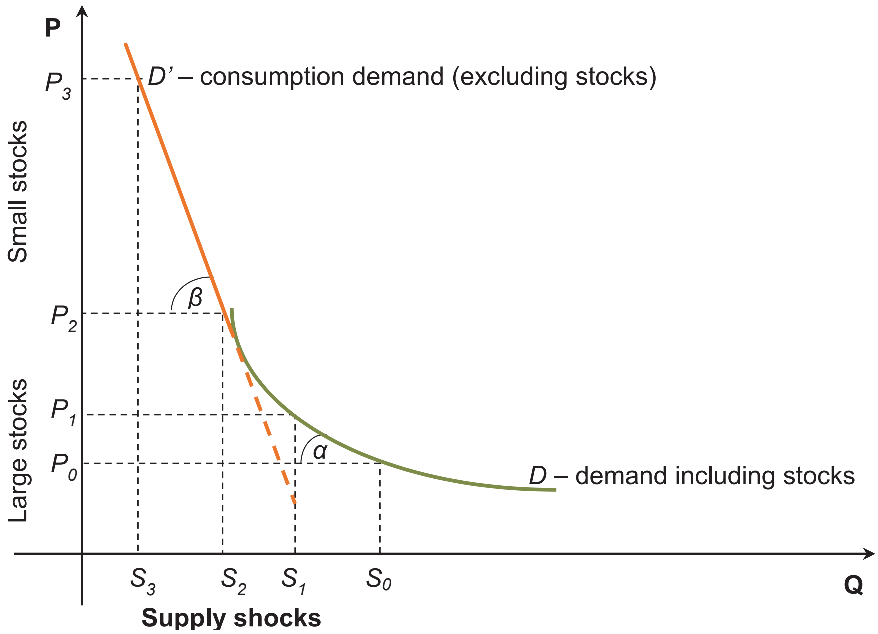
Figure 1.3. Impact of production of biofuels on agri-food sector



Source: Tokgoz S., Zhang W., Msangi S., (2012): Biofuels and the Future of Food: Competition and Complementarities, p. 416, Agriculture 2.

The use of agricultural products for energy purposes not only increases the demand but also makes the economic effects visible on the side of supply. The supply of agricultural products includes crops in a given season as well as closing stocks from the previous season. Stocks play a significant role in balancing the market situation. The relation of closing stocks to use (consumption), which is a synthetic index of the market equilibrium, is often presented in market balance sheets. The impact of the reduction in stocks resulting from the processing of agricultural raw materials into bioethanol and biodiesel may be presented graphically (Fig. 1.4). Under conditions of large stocks and a relatively stable production, use is presented as a curve of the demand function *D*, the flexibility and inclination of which is relatively small (tgα). The reduction in supply from the level S_0 to S_1 may result in a relatively small growth in prices from P_0 to P_1. A different situation occurs when stocks are small and a similar scale of reduction in supply results in a significantly larger growth in prices from P_2 to P_3. Clear changes are also visible on the side of demand, the function of which D' is characterized by much greater flexibility and inclination (tgβ).

Figure 1.4. Impact of production of biofuels on stocks of agricultural products and equilibrium on food market



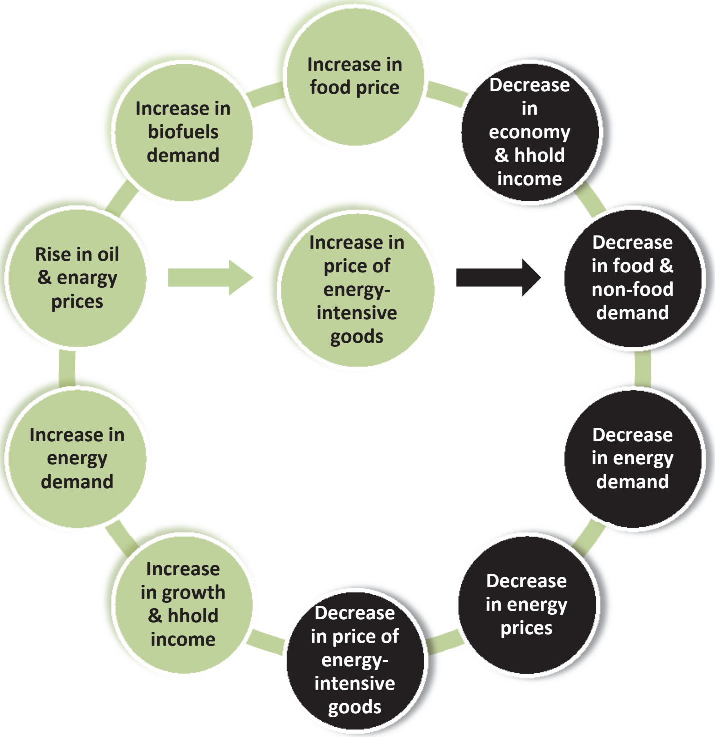
Source: Wright B., Cafiero C., (2011): Grain reserves and food security in the Middle East and North Africa, p. 67, Food Sec. 3.

The prices of energy raw materials and energy are reflected in the prices of goods and services and, as a consequence, they play a crucial role in business cycles. Four basic cycle phases are distinguished in the theory of business cycles: crisis, depression, recovery and prosperity. Two phases are present in contemporary cycles: recession and recovery[3]. The impact of changes in energy prices on the economic situation may be presented graphically with the use of a closed cycle (Fig. 1.5). The slowdown in economic growth (recession) may result in the decrease in household income and, as a result, a decreasing demand, including for food and energy. The prices of energy and the prices of energy--intensive goods decrease next. Low prices result in the growth in demand and the economy slowly starts to enter the recovery phase the symptoms of which include the growing household income. The economic growth and improvement in the purchasing power of consumers result in an increased demand for energy. As a result, the prices of energy and energy raw materials increase and are reflected in the prices of energy-intensive goods and services. Because of high

[3] R. Barczyk, *Nowe oblicza cyklu koniunkturalnego*, PWE, Warsaw 2006.

energy prices and limited resources of fossil energy materials the economies of particular countries begin to produce energy from renewable sources, including from agricultural raw materials. The high prices of energy and food products portend another decreasing phase in the business cycle. The leading role in the cycle presented above is played by the market mechanism, but if the discussion is limited to agricultural products and the production of biofuels, the impact of the economic policy (e.g. energy, agricultural) is very important.

Figure 1.5. Changes in energy prices and business cycle



Source: Msangi S., Tokgoz S., Zhang W., (2012): Biofuels, Agriculture and Food Security: Key Connections & Challenges, Environment & Production Technology Division, IFPRI, Washington.

The Food Price Index, developed by FAO, is a synthetic index of the economic situation and, above all, the variability of food product prices on the global market. The index presents changes in prices regarding the adopted base period. The most valid values of the Food Price Index were calculated regarding the base period covering the years 2002-2004. In 2003-2008, the global food prices demonstrated an upward trend and the value of the index for food in total increased from 98 to 200. High food prices were strongly correlated with the good economic situation on the global market. In 2003-2007, the global GDP in real terms grew systematically by 3.8% to 5.2% annually. The first symptoms of the economic slowdown appeared in 2008, and in 2009 they transformed into an economic crisis. The drop in GDP was also accompanied by the drop in the value of the Global Food Price Indexes. They only exception were the prices of sugar. In 2010-2011, the global economy returned to the path of growth because the global GDP grew in real terms by 4.0% and 3.7% (Tab. 1.2). Similar directions of changes in the global GDP and food prices confirm the validity of previous discussions regarding the connections between the prices of food, energy and fluctuations of the economic situation. The decomposition of the Global Food Price Index illustrates the fact that the prices of cereals, oilseeds and sugar in the examined period were characterized by a higher dynamics than food in total. Thus, it may be assumed that the demand resulting from the production of biofuels played a significant role in the higher growth in prices of the raw materials referred to above.

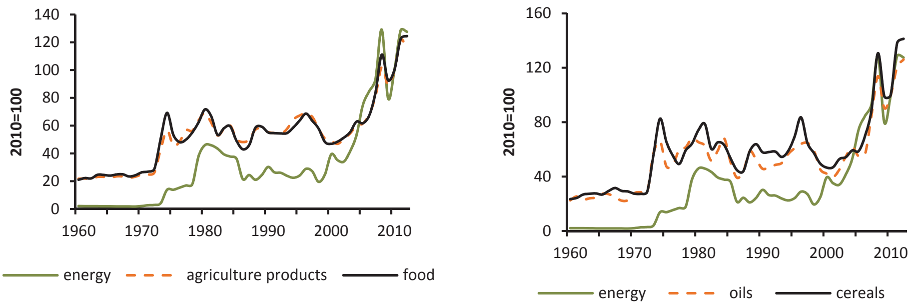
Table 1.2. Global Food Price Indexes and GDP

Years	Food in total	Cereals	Oils and fats	Sugar	Global GDP in real terms
	period 2002-2004 = 100				
2003	98	98	101	101	3.8
2004	112	107	112	102	4.9
2005	117	103	104	140	4.7
2006	127	121	112	210	5.4
2007	159	167	169	143	5.2
2008	200	238	225	182	3.1
2009	157	174	150	257	-0.7
2010	185	183	193	302	4.9
2011	228	247	252	369	3.7
2012	212	241	225	306	

Source: FAO Food Price Index, www.fao.org.

The statistical analysis of dependencies demonstrated the fact that the prices of agricultural products and food in the long-term showed a similar variability as energy prices (Fig. 1.6). The years 1960-2012 saw a very strong statistical dependence between the indexes of energy prices, food prices and agricultural product prices. The values of Pearson's correlation coefficients, which illustrate the strength of the connection, were very high, 0.90-0.91, and statistically significant. A more detailed analysis of the dependence between the prices of energy and cereals as well as fats and oils demonstrated a slightly smaller strength of the connection. The values of correlation coefficients amounted to approx. 0.88 and also were statistically significant. It is also clearly visible in the long-term that the convergence between the variability of global energy and food prices increased in recent years. Until 2004 food prices were characterized by much greater dynamics than energy prices. The next period saw the levelling of dynamics of the prices of agricultural products, food and energy. The main reason for this is the increasing demand for agricultural raw materials, including those used in the production of energy.

Figure 1.6. Indexes of global prices of energy, agricultural products and food



Source: data from the World Bank, www.worldbank.org.

2. Raw materials for production of biofuels as compared to conditions on global markets

2.1. Cereals

2.1.1. Production

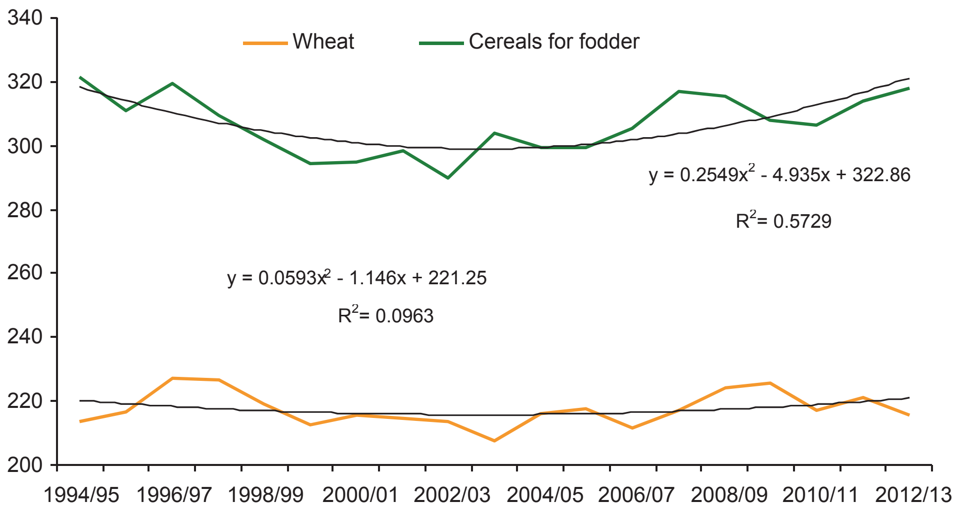
Trends in the global production of cereals changed in the long-term perspective depending on the period and the quality of cereals taken into account. The production of commodity cereals, namely ones which dominate in the global trade (wheat, maize), increased in the second half of the last century.

The growth resulted from the introduction of more fertile varieties, the progress in the technology of cultivation and the intensification of production as well as from the increasing acreage of cultivation. The production of cereals for fodder and/or ones of local significance – oats and rye, decreased. The growth in the production of the former more than compensated the decrease in the production of the latter, and that is why the production of cereals was increasing. These tendencies changed in the current century. Substantial fluctuations in the production of cereals took place.

Changes in acreage, both the acreage of cereals for fodder and wheat, were characterized by similar trends. The reaction strength of the latter was greater. In the first half of the analysed period (seasons 1994/95-2003/04), the area of wheat cultivation decreased by an average of approx. 1 million ha annually and cereals for fodder – by almost 3 million ha. The decreasing trend was reversed in the second half of the period and the acreage of wheat increased at a pace of 1.5 million ha per year, while the acreage of cereals for fodder – more than 2.8 million ha annually. The trend was reversed in the second half of the analysed period and the acreage of wheat increased by 0.5 million ha and the acreage of cereals for fodder – by an average of 1.8 million ha annually. Changes in the area of cereals cultivation resulted from changes in the profitability of cereals production, also from the relative perspective (as compared to other cultivations competing for land in crop rotation). Greater changes in the acreage of cereals for fodder than wheat prove that the flexibility of production of the former (reaction strength to changes in market conditions) is greater which is connected with the more diverse structure of demand for these cereals.

The area of cultivation of wheat and cereals for fodder decreased accordingly by 2.3 and 3.9% in the first half of the past decade (seasons 2000/01--2005/06) as compared to the second half of the 1990s (1994/95-1999/00). In the next period (seasons 2006/07-2012/13), namely in the second half of the previous decade, and at the beginning of the current decade, further growth in the acreage of cereals cultivation took place. It almost reached the level recorded at the end of the last century (wheat) or slightly exceeded it (cereals for fodder). As compared to this period, the cultivation of wheat was limited, above all, in North America (mostly in the USA), East Asia and to a much smaller degree in the Middle East. On the other hand, its area increased in the CIS (Russia, Ukraine), Oceania (Australia) and in South America (Argentina) and it slightly increased in Africa and in the EU (Germany, France). Furthermore, the area of cereals for fodder increased mostly in developing countries (Africa, Asia, South America) and in Oceania and decreased, primarily, in the CIS, the EU, North America and South Asia.

Figure 2.1. Acreage of wheat and cereals for fodder in the world (million ha)



At that time the efficiency from one hectare increased. In 2012, the average crops of wheat and cereals for fodder were larger by, accordingly, 31% and 42% than in 1994. The crops of wheat was growing at a pace of 0.033 t/ha annually in the examined period, while the crops of cereals for fodder – almost twice as fast (0.059 t/ha annually).

Table 2.1. Acreage of wheat cultivation in the world (million ha)

Specification	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	Dynamics in %		
	[1]	[2]	[3]	[2]/[1]	[3]/[2]	[3]/[1]
CIS	42.015	43.886	47.637	104.5	108.5	113.4
South Asia	37.586	37.708	40.401	100.3	107.1	107.5
North America	36.282	30.742	29.866	84.7	97.2	82.3
EU-28	25.404	26.027	25.719	102.5	98.8	101.2
East Asia	29.933	24.089	24.530	80.5	101.8	81.9
Middle East	18.562	18.941	18.110	102.0	95.6	97.6
Oceania	10.439	12.332	13.253	118.1	107.5	127.0
South America	8.174	9.568	8.628	117.1	90.2	105.6
Africa	9.432	9.640	9.741	102.2	101.0	103.3
Other	1.386	1.200	1.044	86.6	87.0	75.3
World in total	**219.213**	**214.132**	**218.929**	**97.7**	**102.2**	**99.9**

Source: USDA.

Table 2.2. Acreage of cultivation of cereals for fodder in the world (million ha)

Specification	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	Dynamics in %		
	[1]	[2]	[3]	[2]/[1]	[3]/[2]	[3]/[1]
Africa	67.651	69.613	78.519	102.9	112.8	116.1
North America	53.352	50.829	51.595	95.3	101.5	96.7
South Asia	37.343	36.535	43.138	97.8	118.1	115.5
EU-28	34.853	33.546	31.941	96.2	95.2	91.6
South-East Asia	34.809	32.159	30.372	92.4	94.4	87.3
CIS	35.507	29.474	27.223	83.0	92.4	76.7
South America	21.168	20.729	24.419	97.9	117.8	115.4
Middle East	10.027	9.350	8.983	93.2	96.1	89.6
Oceania	4.823	5.957	6.021	123.5	101.1	124.8
Other	10.042	9.318	9.760	92.8	104.7	97.2
World in total	**309.576**	**297.509**	**311.971**	**96.1**	**104.9**	**100.8**

Source: USDA.

When comparing the average values of crops from the period 2005/06--2012/2013 with the period 1994/95-1999/00 (eliminating short-term fluctuations resulting from random factors), the growth in wheat crops by 15% is observed, while in case of crops of cereals for fodder – by 23%. In the case of the latter, the growth in crops involved the introduction of GMO maize into cultivation and its quick expansion. In addition, crops were growing as a result of the technological progress regarding cultivation and the intensification of production, especially in developing countries where average crops increased from 30% to 60% over the last 15 years. The largest growth was observed in the CIS, South-East Asia, South America and South Asia, namely mostly in importer regions. Only crops in

Oceania decreased which resulted from changes in climate conditions (smaller level of precipitation) in Australia.

Figure 2.2. Average harvest of wheat and cereals for fodder in the world (t/ha)

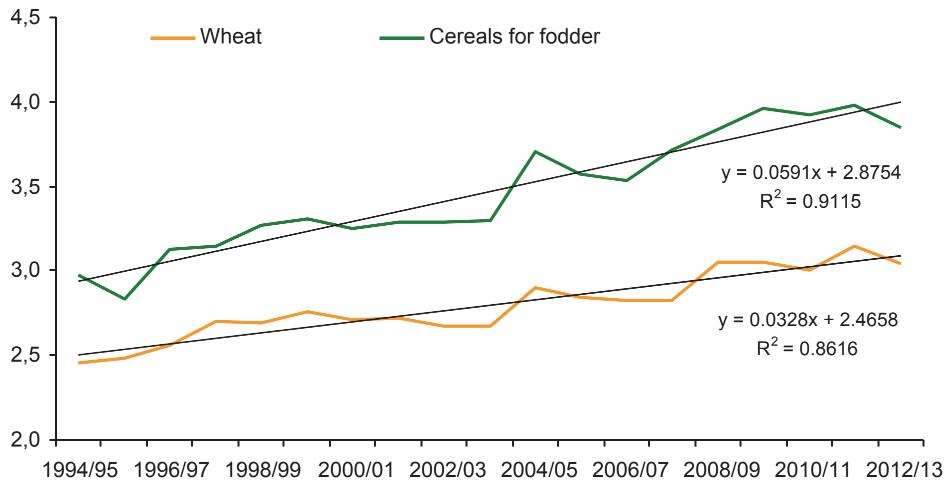


Table 2.3. Changes in average crops of cereals in the world

Specification	Relationships in % 2005/06-2012/13 / 1994/95-1999/00	
	Wheat	Cereals for fodder
South-East Asia	158.6	153.1
CIS	133.4	152.6
South America	121.1	151.2
South Asia	116.6	146.8
North America	113.8	125.3
Central America	61.0	125.0
Middle East	115.8	122.4
Caribbean	-	121.2
South Africa	139.3	119.7
East Asia	127.3	114.6
North Africa	128.1	112.8
EU	108.1	110.8
Other European countries	110.2	110.5
Oceania	88.2	98.0
World	**114.7**	**123.0**

Source: own calculations on the basis of data from USDA.

Relatively high fluctuations of cereal crops took place in 1994-2012 which was caused by variable climate conditions. However, a clear upward trend was visible. The average growth rate of wheat crops amounted to 7.3 million tonnes annually. The crops of cereals for fodder were growing significantly faster (by 18.3 million tonnes annually on average). The information above demonstrates the fact that the production of cereals was increasing as a result of growing crops. The higher growth rate in the production of cereals for fodder resulted from greater progress in yielding.

The global harvest of wheat in the period 2005/06-2010/11 as compared to the period 1995/96-1999/00 increased by almost 15%. The growth occurred both in exporter regions, namely in South America (Argentina, Brazil), the EU and the CIS countries, which joined the group of significant exporters as a result of growing production, and in loss-making regions – Africa, South Asia, East Asia, the Middle East. Production grew to the greatest extent in the CIS and in developing countries. The production of wheat was reduced only in North America where its acreage decreased for the benefit of cereals for fodder and soy.

Figure 2.3. Harvest of wheat and cereals for fodder in the world (million tonnes)

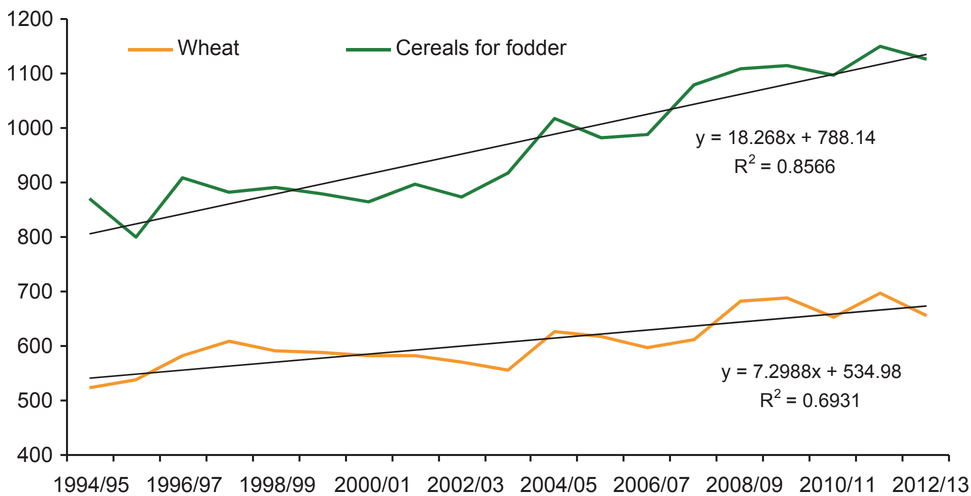


Table 2.4. Harvest of wheat in the world (million ha)

Specification	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	Dynamics in %		
	[1]	[2]	[3]	[2]/[1]	[3]/[2]	[3]/[1]
EU-28	123.383	130.401	135.135	105.7	103.6	109.5
East Asia	110.721	94.428	115.440	85.3	122.3	104.3
South Asia	87.607	95.804	109.957	109.4	114.8	125.5
CIS	63.912	81.230	97.134	127.1	119.6	152.0
North America	92.925	81.976	87.412	88.2	106.6	94.1
Middle East	33.954	39.031	38.485	115.0	98.6	113.3
South America	18.402	22.228	23.260	120.8	104.6	126.4
Oceania	19.248	21.939	21.387	114.0	97.5	111.1
Africa	16.874	18.651	22.950	110.5	123.1	136.0
Other	4.539	3.902	3.761	86.0	96.4	82.9
World in total	**571.565**	**589.588**	**654.921**	**103.2**	**111.1**	**114.6**

Source: USDA.

The harvest of cereals for fodder increased in the period 2005/06-2010/11 as compared to the period 1995/96-1999/00 by almost 26%. Growth was recorded in all production regions in the world. The largest growth was observed, as in the case of wheat, in developing countries – South America, East Asia and South-East Asia where the scale of growth ranged from 30 to 75%.

Table 2.5. Harvest of cereals for fodder in the world (million ha)

Specification	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	Dynamics in %		
	[1]	[2]	[3]	[2]/[1]	[3]/[2]	[3]/[1]
North America	309.044	329.698	373.938	106.7	113.4	121.0
East Asia	131.982	131.755	181.524	99.8	137.8	137.5
EU-28	146.456	149.818	148.434	102.3	99.1	101.4
South America	60.057	71.625	105.505	119.3	147.3	175.7
Africa	77.118	84.247	104.831	109.2	124.4	135.9
CIS	55.719	57.759	65.077	103.7	112.7	116.8
South Asia	35.620	37.863	45.626	106.3	120.5	128.1
South-East Asia	16.529	19.778	26.823	119.7	135.6	162.3
Middle East	16.989	17.799	18.500	104.8	103.9	108.9
Oceania	9.540	12.073	11.536	126.5	95.5	120.9
Other	12.719	12.319	13.426	96.9	109.0	105.6
World in total	**871.773**	**924.733**	**1095.220**	**106.1**	**118.4**	**125.6**

Source: USDA.

The geographic structure of wheat production did not change greatly in the examined period but several facts should be emphasized. The share of two large surplus regions decreased, namely the EU (by 1.0 percentage point) and North America (by 3.0 percentage points) as well as the largest importer – East Asia (by 1.8 percentage point). On the contrary, the share of the CIS increased (by 3.7 percentage points) which made the CIS a serious exporter of wheat. The share of importer regions, such as South Asia and Africa, also increased.

Changes in the geographic structure of the production of cereals for fodder were smaller but certain trends could be identified here as well. First of all, the share of importer regions increased – South-East Asia and Africa, as well as a surplus region, namely South America. The share of the EU decreased significantly as did the share of North America and, to a smaller, extent the CIS.

Figure 2.4. Changes in structure of wheat production in the world (%)

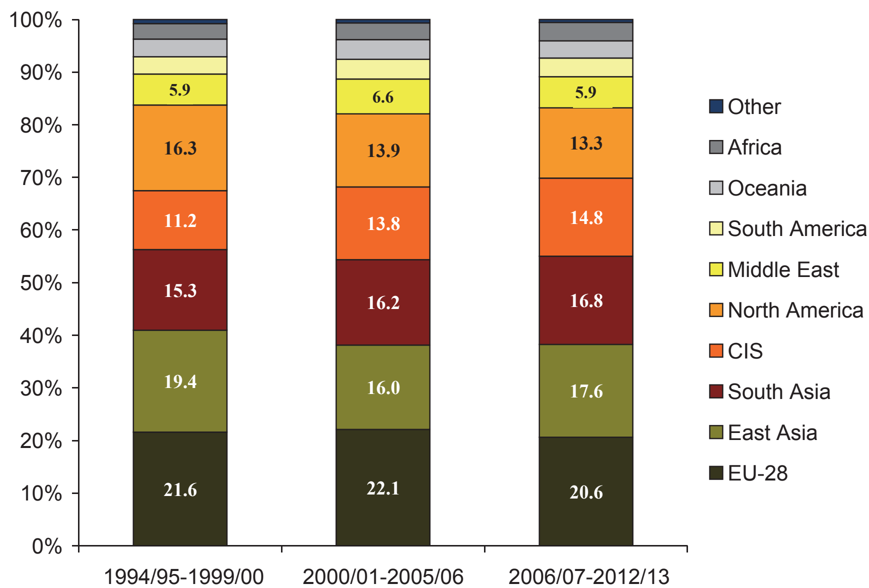
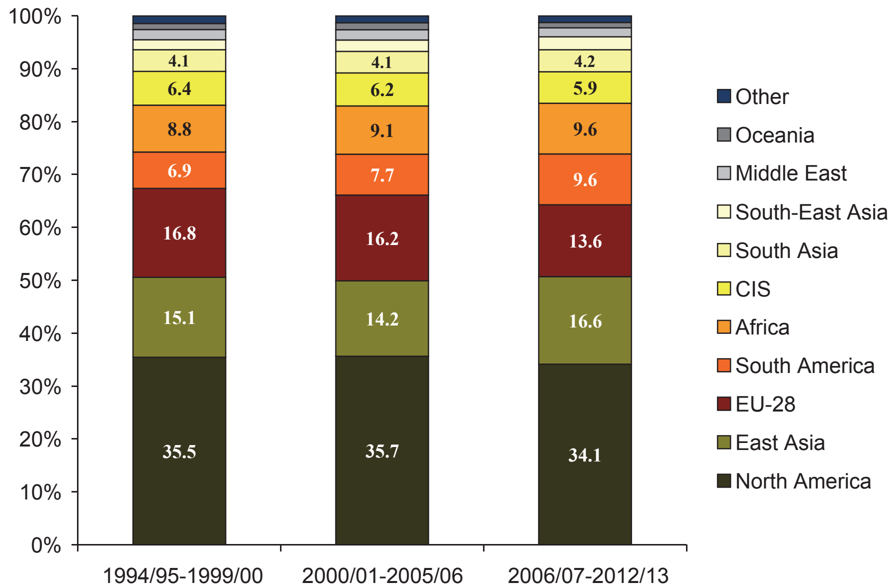


Figure 2.5. Changes in structure of production of cereals for fodder in the world (%)



The largest producers of wheat in the world include both deficit countries in terms of its production, e.g. China, India, Pakistan as well as countries with permanent, structural surpluses. The latter, include five largest exporters – the EU, the USA, Australia, Canada, Argentina and other countries significant on the international market – Russia and Ukraine, particularly in recent years. Special attention should be paid to the growth in production in Russia, accordingly, by 53% and 18% as compared to the second half of the 1990s. Some importer countries also increased their production in recent years (India, Pakistan).

The production of wheat in the world is strongly concentrated in a relatively small group of countries. The ten largest producers deliver nearly 90% of the current global supply. However, the value of this proportion decreases in the examined period.

Table 2.6. Production of wheat by major producers, exporters and their shares (million tonnes, %)

Specification	Production in million tonnes			Relationships in %		
	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	[2]/[1]*	[3]/[2]*	[3]/[1]*
	[1]	[2]	[3]			
EU-28	123.383	130.401	135.258	105.7	103.7	109.6
China	109.830	93.282	114.133	84.9	122.4	103.9
India	65.648	70.895	80.994	108.0	114.2	123.4
USA	63.981	56.182	58.509	87.8	104.1	91.4
Russia	33.226	43.194	50.757	130.0	117.5	152.8
Canada	25.502	22.787	25.245	89.4	110.8	99.0
Australia	18.963	21.625	21.006	114.0	97.1	110.8
Pakistan	17.054	19.771	23.104	115.9	116.9	135.5
Ukraine	15.101	15.320	18.509	101.5	120.8	122.6
Turkey	16.117	17.350	17.079	107.7	98.4	106.0
10 largest in total	**488.805**	**490.806**	**544.594**	**100.4**	**111.0**	**111.4**
Share of 10 largest (%)	***85.5***	***83.2***	***83.1***	***-2.3***	***-0.1***	***-2.4***
World	**571.565**	**589.588**	**654.921**	**103.2**	**111.1**	**114.6**
Five largest exporters [5 EX]						
EU-28	123.383	130.401	135.258	105.7	103.7	109.6
USA	63.981	56.182	58.509	87.8	104.1	91.4
Australia	18.963	21.625	21.006	114.0	97.1	110.8
Canada	25.502	22.787	25.245	89.4	110.8	99.0
Argentina	13.543	15.083	14.300	111.4	94.8	105.6
Total	**245.373**	**246.078**	**254.318**	**100.3**	**103.3**	**103.6**
Share in global production (%)	***42.9***	***41.7***	***38.8***	***-1.2***	***-2.9***	***-4.1***
Exporters from Black Sea basin [BSB]						
Russia	33.226	43.194	50.757	130.0	117.5	152.8
Ukraine	15.101	15.320	18.509	101.5	120.8	122.6
Kazakhstan	8.022	11.191	14.532	139.5	129.9	181.1
Total	**56.350**	**69.705**	**83.798**	**123.7**	**120.2**	**148.7**
Share in global production (%)	***9.9***	***11.8***	***12.8***	***2.0***	***1.0***	***2.9***

*) difference in percentage points in the case of share.

Source: own calculations on the basis of data from USDA.

The global commercial supply (export surpluses) is determined by five countries, the largest exporters – Argentina, Australia, Canada, the EU and the USA and countries from the Black Sea basin in recent years as well (Russia, Ukraine and Kazakhstan). While the share of the first group in the examined period is systematically decreasing, the share of the second group is increasing. Both groups produce more than 50% of the global wheat harvest.

Table 2.7. Production of wheat by major importers and their shares (million tonnes, %)

Specification	Production in million tonnes			Relationships in %		
	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	[2]/[1]*	[3]/[2]*	[3]/[1]*
	[1]	[2]	[3]			
China	109.830	93.282	114.133	84.9	122.4	103.9
Turkey	16.117	17.350	17.079	107.7	98.4	106.0
Iran	10.464	12.052	13.503	115.2	112.0	129.0
Egypt	5.640	6.764	8.164	119.9	120.7	144.8
Brazil	2.305	4.067	4.721	176.5	116.1	204.8
Morocco	3.565	3.631	4.657	101.9	128.3	130.6
Algeria	1.589	2.007	2.799	126.3	139.4	176.1
Mexico	3.442	3.007	3.645	87.4	121.2	105.9
Iraq	1.497	2.353	2.276	157.1	96.8	152.0
Tunisia	1.121	1.301	1.204	116.1	92.5	107.4
Japan	0.536	0.801	0.781	149.6	97.5	145.9
Saudi Arabia	1.845	2.376	1.561	128.8	65.7	84.6
Sudan	0.472	0.327	0.526	69.3	161.0	111.5
The above in total	**158.422**	**149.317**	**175.049**	**94.3**	**117.2**	**110.5**
Share in global production (%)	*27.7*	*25.3*	*26.7*	*-2.4*	*1.4*	*-1.0*
5 largest	**144.356**	**133.515**	**157.599**	**92.5**	**118.0**	**109.2**
Share in global production (%)	*25.3*	*22.6*	*24.1*	*-2.6*	*1.4*	*-1.2*
10 largest	**155.570**	**145.814**	**172.180**	**93.7**	**118.1**	**110.7**
Share in global production (%)	*27.2*	*24.7*	*26.3*	*-2.5*	*1.6*	*-0.9*

*) difference in percentage points in the case of share.

Source: own calculations on the basis of data from USDA.

The share of the 10 major importers in the global production of wheat ranges from 26-27%. It is characterized by a small downward trend. The growth in production proceeds in most deficit countries in the production of this cereal, while its dynamics is almost equal to the dynamics of production growth in major producers and exceeds the dynamics of production growth by exporters (apart from the CIS countries). Production increased to the greatest extent for such importers as Brazil (two times), Algeria (by 76%), Iraq, Japan, Egypt, Morocco (by 30-50%).

The production of cereals for fodder is slightly less concentrated than the production of wheat. The share of the 10 largest producers of these cereals in recent years reached 80%. It is characterized by a minimum downward trend and is dominated by three countries: the USA, China and the EU. The dynamics of production growth of major producers is slightly smaller than the global production. The share of the largest exporters (the USA, Argentina, Ukraine, Brazil and Australia) exceeds 40% and is growing systematically. The highest growth in production took place in Brazil and Ukraine (accordingly by 84.0% and 85.5%). The decrease in the production of these cereals among the largest producers was recorded in recent years only in Canada and Russia.

Table 2.8. Production of cereals for fodder by major producers and exporters and their shares (million tonnes, %)

Specification	Production in million tonnes			Relationships in %		
	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	[2]/[1]*	[3]/[2]*	[3]/[1]*
	[1]	[2]	[3]			
USA	259.015	278.614	320.636	107.6	115.1	123.8
China	126.236	127.543	177.948	101.0	139.5	141.0
EU-28	146.445	149.818	148.521	102.3	99.1	101.4
Brazil	34.305	42.015	63.634	122.5	151.5	185.5
Russia	30.949	29.912	29.542	96.6	98.8	95.5
Argentina	18.436	20.069	29.200	108.9	145.5	158.4
Mexico	24.200	27.173	29.007	112.3	106.8	119.9
India	21.103	22.191	27.666	105.2	124.7	131.1
Canada	25.829	23.912	24.408	92.6	102.1	94.5
Ukraine	13.034	17.024	23.988	130.6	140.9	184.0
10 largest in total	699.551	738.268	874.547	105.5	118.5	125.0
Share of 10 largest (%)	*80.2*	*79.8*	*79.9*	*-0.4*	*0.0*	*-0.4*
World	**872.2**	**913.1**	**1062.9**	**104.7**	**116.4**	**121.9**
Five largest exporters						
USA	259.015	278.614	320.636	107.6	115.1	123.8
Brazil	34.305	42.015	63.634	122.5	151.5	185.5
Canada	25.829	23.912	24.408	92.6	102.1	94.5
Argentina	18.436	20.069	29.200	108.9	145.5	158.4
Australia	8.937	11.482	10.930	128.5	95.2	122.3
Total	**346.522**	**376.090**	**448.806**	**108.5**	**119.3**	**129.5**
Share in global production (%)	*39.7*	*40.7*	*41.0*	*0.9*	*0.3*	*1.2*

*) difference in percentage points in the case of share.

Source: own calculations on the basis of data from USDA.

The production of cereals for fodder by the largest importers demonstrates a clear upward trend. The dynamics of its growth clearly exceeds the dynamics of the global production of these cereals and their production by major producers, particularly exporters. The highest growth in production took place in relatively small importers – Algeria (3.4 times), countries in South America – Peru, Chile, Colombia (by 20-90%). On the other hand, a relatively high growth in production took place in large producers-importers such as China or Mexico (by 20-40%). A decrease in production is observed in case of importers characterized by small production of cereals for fodder which happens for various reasons: an unfavourable climate or the lack of adequate arable land. The significance of major importers in the production of cereals for fodder is much smaller than in the case of wheat, it reaches more than 20% and demonstrates a moderate upward trend.

Table 2.9. Production of cereals for fodder by major importers and their shares (million tonnes, %)

Specification	Production in million tonnes			Relationships in %		
	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	[2]/[1]*	[3]/[2]*	[3]/[1]*
	[1]	[2]	[3]			
Mexico	129.242	129.510	179.466	100.2	138.6	138.9
China	24.200	27.173	29.007	112.3	106.8	119.9
Egypt	6.617	6.901	7.210	104.3	104.5	109.0
Iran	3.560	4.201	4.835	118.0	115.1	135.8
Columbia	1.286	1.621	1.803	126.0	111.3	140.2
Peru	0.983	1.532	1.734	155.8	113.2	176.3
Algeria	0.411	0.737	1.380	179.4	187.2	335.8
Venezuela	1.470	1.659	1.802	112.9	108.6	122.6
Saudi Arabia	0.886	0.360	0.416	40.6	115.5	46.9
South Korea	0.402	0.361	0.219	89.9	60.8	54.6
Japan	0.207	0.206	0.185	99.7	89.5	89.2
Malaysia	0.047	0.070	0.093	149.1	132.0	196.9
Taiwan	0.228	0.065	0.052	28.5	80.2	22.8
The above in total	**169.538**	**174.397**	**228.202**	**102.9**	**130.9**	**134.6**
Share of the above in global production (%)	*19.4*	*18.9*	*20.8*	*-0.6*	*2.0*	*1.4*
5 largest	**164.905**	**169.406**	**222.322**	**102.7**	**131.2**	**134.8**
Share in global production (%)	*18.9*	*18.3*	*20.3*	*-0.6*	*2.0*	*1.4*
10 largest	**169.056**	**174.055**	**227.873**	**103.0**	**130.9**	**134.8**
Share in global production (%)	*19.4*	*18.8*	*20.8*	*-0.6*	*2.0*	*1.4*

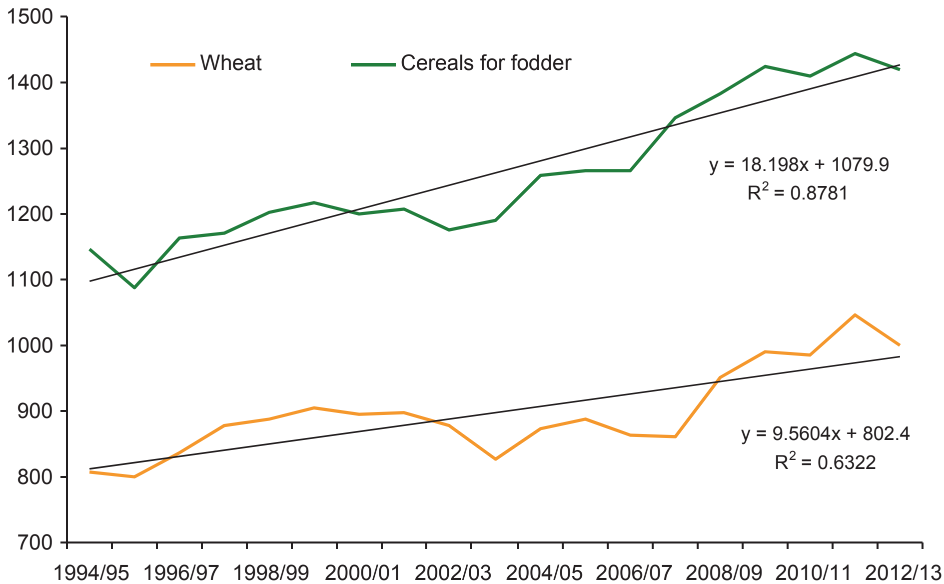
*) difference in percentage points in the case of share.

Source: own calculations on the basis of data from USDA.

2.1.2. Use

The global use of cereals demonstrates a long-term upward trend. The dynamics of this process intensified particularly in 1994/95-2012/13. Its structure changes at the same time. These changes result from several reasons. The major ones include the growth in the population's income and the related change in eating habits, the growth in the number of people as well as the technological progress. A higher dynamics of growth is demonstrated by the use of cereals for fodder which grew in the examined period by an average of 18 million tonnes annually. The use of wheat grew by almost 10 million tonnes annually, but its variability was significantly lower than the variability of the use of cereals for fodder. This difference is related to the structure of use and characteristic properties of its particular components.

Figure 2.6. Global use of cereals (million tonnes)



No greater shifts within the structure of the use of wheat occurred in the examined period which is dominated by elements less flexible in terms of prices, especially consumption, with the share of approx. 80% and only less than 20% is used for fodder. This means that the fluctuations of market prices result in relatively small changes in components dominating in the use of wheat. As a result, changes in its use are relatively smaller.

Figure 2.7. Structure of global use of wheat (%)

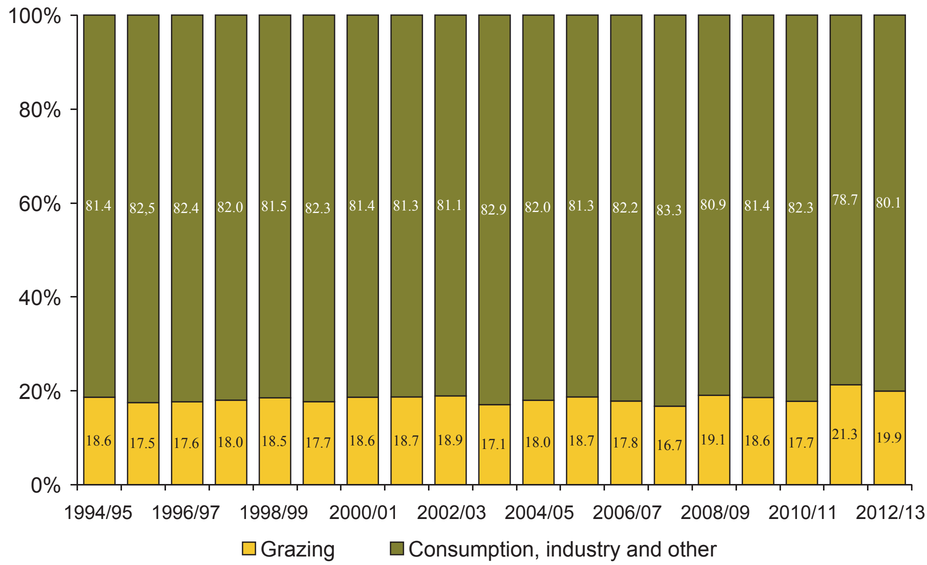
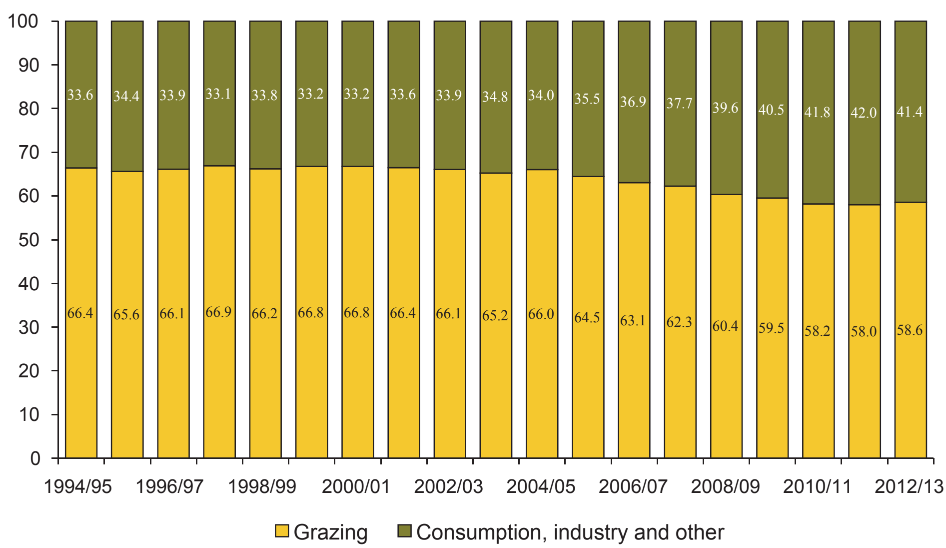


Figure 2.8. Structure of global use of cereals for fodder (%)



On the other hand, grazing dominates in the structure of the use of cereals for fodder but its share shows a downward trend. Its share decreased by almost 8 percentage points in the examined period, namely to a significant extent. Despite this fact, relatively significant changes in the volume of cereals intended for grazing were reflected in larger fluctuations of the use of cereals for fodder.

The global use of wheat in the second half of the previous decade (seasons 2006/07-2012/13) was higher by over 15% than the use in the second half of the 1990s (seasons 1994/95-1999/00). Other expenditures grew to a similar degree and grazing grew to a slightly greater degree. The growth in the use of cereals for fodder was more than twice greater (growth by nearly 30%). This was, primarily, the result of the dynamic growth in industrial use, and consumption to a smaller degree.

Table 2.10. Global use of wheat and cereals for fodder (million tonnes)

Specification	Use in million tonnes			Relationships in %		
	1994/95- -1999/00	2000/01- -2005/06	2006/07- -2012/13	[2]/[1]	[3]/[2]	[3]/[1]
	[1]	[2]	[3]			
Wheat						
Grazing	101.609	109.344	122.096	107.6	111.7	120.2
Consumption, industrial use, other	462.895	487.035	527.928	105.2	108.4	114.0
Total	**564.504**	**596.379**	**650.024**	**105.6**	**109.0**	**115.1**
Cereals for fodder						
Grazing	571.083	614.195	653.912	107.5	106.5	114.5
Consumption, industrial use, other	289.956	320.098	438.970	110.4	137.1	151.4
Total	**861.040**	**934.292**	**1092.882**	**108.5**	**117.0**	**126.9**

Source: own calculations on the basis of data from USDA.

The highest growth in the use of wheat took place in the poorest countries and in developing countries – South-East Asia, Africa, South America, and in the Middle East. This was related to the increase in the number of people as well as the improvement in the economic situation of the population. The growth in the use of wheat in developed countries was significantly lower. However, the dynamics of this process in countries such as the EU or the USA was also high.

Use on the market of cereals for fodder increased to the largest extent also in the poorest countries and in developing countries. However, the use of these cereals grew dynamically, apart from this group of countries, also in developed countries of North America. The reason for growth in developing countries was the increase in the demand for fodder and the growth in the use of cereals in the biofuel sector in North America (mostly maize in the USA).

The share of East Asia, North America and the EU, namely developed countries, decreased in the geographic structure of the use of wheat. The role of developing countries – Africa and South-East Asia, increased.

Table 2.11. Use of wheat and cereals for fodder in major regions of the world (million tonnes)

Specification	Use in million tonnes			Relationships in %		
	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	[2]/[1]	[3]/[2]	[3]/[1]
	[1]	[2]	[3]			
Wheat						
East Asia	119.972	117.535	124.314	98.0	105.8	103.6
EU-28	109.838	121.989	123.900	111.1	101.6	112.8
CIS	69.253	69.720	75.537	100.7	108.3	109.1
Africa	38.032	45.641	58.195	120.0	127.5	153.0
Middle East	45.115	48.737	54.036	108.0	110.9	119.8
North America	47.752	46.037	46.927	96.4	101.9	98.3
South America	20.601	23.533	25.296	114.2	107.5	122.8
South-East Asia	8.467	10.460	13.695	123.5	130.9	161.8
Oceania	4.805	6.761	7.559	140.7	111.8	157.3
Other	100.671	105.966	120.565	105.3	113.8	119.8
World in total	**564.504**	**596.379**	**650.024**	**105.6**	**109.0**	**115.1**
Cereals for fodder						
North America	256.838	286.679	341.417	111.6	119.1	132.9
East Asia	159.259	174.215	212.358	109.4	121.9	133.3
EU	142.082	148.205	153.378	104.3	103.5	108.0
Africa	83.841	95.103	116.245	113.4	122.2	138.6
South America	56.476	61.590	79.945	109.1	129.8	141.6
CIS	55.946	51.952	51.716	92.9	99.5	92.4
Middle East	29.178	32.929	38.992	112.9	118.4	133.6
South-East Asia	20.121	23.147	31.700	115.0	137.0	157.5
Europe – other countries	9.402	8.599	8.271	91.5	96.2	88.0
Other	47.896	51.876	58.861	108.3	113.5	122.9
World in total	**861.040**	**934.292**	**1092.882**	**108.5**	**117.0**	**126.9**

Source: own calculations on the basis of data from USDA.

The share of developed countries decreased also in the geographic structure of the use of cereals for fodder, apart from North America. The significance of developing countries, particularly South America and Africa, grew.

Table 2.12. Structure of use of wheat and cereals for fodder in major regions of the world (%)

Specification	Share in %			Changes in percentage points		
	1994/95- -1999/00	2000/01- -2005/06	2006/07- -2012/13	[2]-[1]	[3]-[2]	[3]-[1]
	[1]	[2]	[3]			
Wheat						
East Asia	21.25	19.71	19.12	-1.5	-0.6	-2.1
EU-28	19.46	20.45	19.06	1.0	-1.4	-0.4
CIS	12.27	11.69	11.62	-0.6	-0.1	-0.6
Africa	6.74	7.65	8.95	0.9	1.3	2.2
Middle East	7.99	8.17	8.31	0.2	0.1	0.3
North America	8.46	7.72	7.22	-0.7	- 0.5	-1.2
South America	3.65	3.95	3.89	0.3	-0.1	0.2
South-East Asia	1.50	1.75	2.11	0.3	0.4	0.6
Oceania	0.85	1.13	1.16	0.3	0.0	0.3
Other	17.83	17.77	18.55	-0.1	0.8	0.7
World in total	**100.0**	**100.0**	**100.0**	**x**	**x**	**x**
Cereals for fodder						
North America	29.8	30,7	31.2	0.9	0.6	1.4
East Asia	18.5	18.6	19.4	0.2	0.8	0.9
EU	16.5	15.9	14.0	-0.6	-1.8	-2.5
Africa	9.7	10.2	10.6	0.4	0.5	0.9
South America	6.6	6.6	7.3	0.0	0.7	0.8
Other	5.6	5.6	5.4	0.0	-0.2	-0.2
CIS	6.5	5.6	4.7	-0,9	-0.8	-1.8
Middle East	3.4	3.5	3.6	0.1	0.0	0.2
South-East Asia	2.3	2.5	2.9	0.1	0.4	0.6
Europe – other countries	1.1	0.9	0.8	-0.2	-0.2	-0.3
World in total	**100.0**	**100.0**	**100.0**	**x**	**x**	**x**

Source: own calculations on the basis of data from USDA.

2.1.3. Trade

The market of cereals in the global perspective is relatively "shallow". This means that international trade includes a relatively small percentage of the global production of cereals despite clearly different locations of production and use. The commercial turnover in recent years covers 120-130 million tonnes of wheat and 115-120 million tonnes of cereals for fodder. The volume of trade shows clear upward trends. Because of the low flexibility of demand for cereals the fluctuations of crops in the scale of countries and continents of the world result in disproportionately stronger fluctuations of the volume of commercial turnover. The growth in crops of cereals in countries and regions deficit in their production usually leads to a reduction, while the decrease in crops – to an increase in commercial turnover. Stocks kept in exporter countries stabilize the global turnover of cereals trade.

The group of net importers includes both economically developed countries and developing countries, while its composition is highly labile. There is quite a numerous group of countries oscillating on the border of self-sufficiency in the production of cereals which appear on the global market as their importers, sometimes on a substantial scale (in the years of crop failure). India is a typical example thereof.

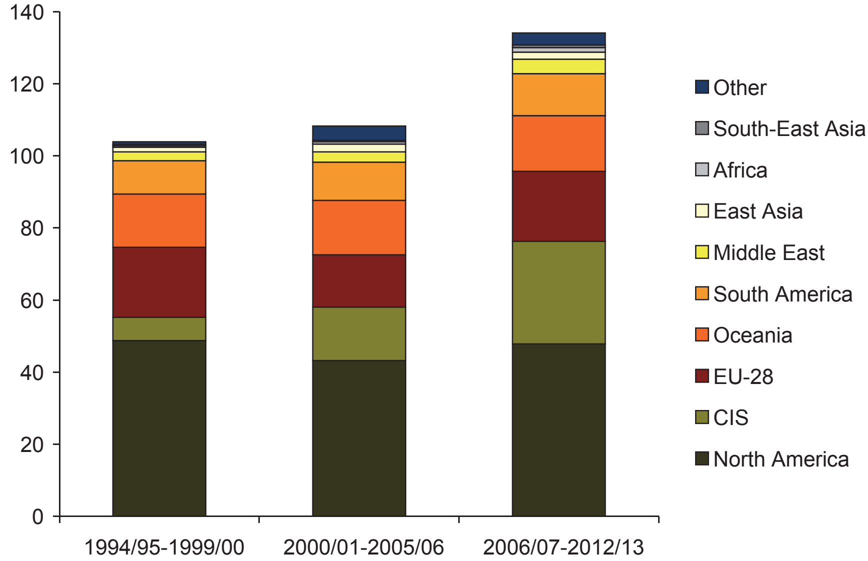
The import needs of economically developed countries deficit in the production of cereals (Japan, the EU and the CIS countries) played a key role in shaping the absorptivity of the global market of cereals until recently. The situation changed radically upon Western and Eastern Europe's transformation into surplus regions, first, in the production of wheat and slightly later also in the production of cereals for fodder. The market's absorptivity is determined to a growing extent, mainly, by import needs of a considerable group of developing countries in the region of Asia, Africa and Latin America.

The national production of cereals covers the needs of the internal market with a surplus in a relatively small group of countries. The USA, Canada, Australia and Argentina – countries distinguished by vast resources of land and usually with a high technical level of agriculture, have had permanent surpluses of cereals for decades. They are defined as structural exporters of cereals. This group was quite recently joined by the EU countries with small food supply areas but with a very efficient agriculture and the CIS countries even later (Russia, Ukraine, Kazakhstan).

Export

The global turnover in wheat increased over the last two decades along with the growing demand for wheat in different regions of the world, especially in Asian countries. The average annual volume of the global export of wheat in the second half of the 1990s was assessed at slightly more than 100 million tonnes. The average volume of turnover in wheat in the seasons 2000/01-2005/06 amounted to 108 million tonnes annually. The clear increase in turnover took place in subsequent seasons and is currently estimated at more than 130 million tonnes annually.

Figure 2.9. Global export of wheat (million tonnes)



Export surpluses of wheat are concentrated in several regions of the world. The main countries exporting wheat include: the USA, Canada, Australia, Argentina and the EU. The significance of the CIS countries in the present and in the past decade is higher than previously. More than 90% of turnover on the global market of wheat comes from the regions referred to above. It should be noted that the growth in export took place, as a matter of principle, in developing countries, namely in the CIS, Africa, South-East Asia, the Middle East or South America. Developed countries experienced stagnation in this respect.

Both the significance of particular regions in the export market and the concentration of wheat export changed in the examined period. The share of North America, the EU and Oceania decreased significantly in the period 2006/07-2012/13 as compared to the second half of the 1990s. In other words, the role of developed exporter countries decreased. Their place was taken by the CIS countries, whose significance as exporters of wheat, grew considerably in recent years. However, it should be pointed out that production in these countries is characterized by a significantly higher variability.

The changes referred to above resulted in the reduction in the concentration of export supply and export on the global market. The shares of the 5 and 10 largest exporters of wheat in the second half of the 1990s amounted to, accordingly, more than 80% and more than 95%. These proportions were reduced in recent years to, accordingly, 72% and 92% which demonstrates the decreasing significance of previous leaders in this field for the benefit of smaller exporters.

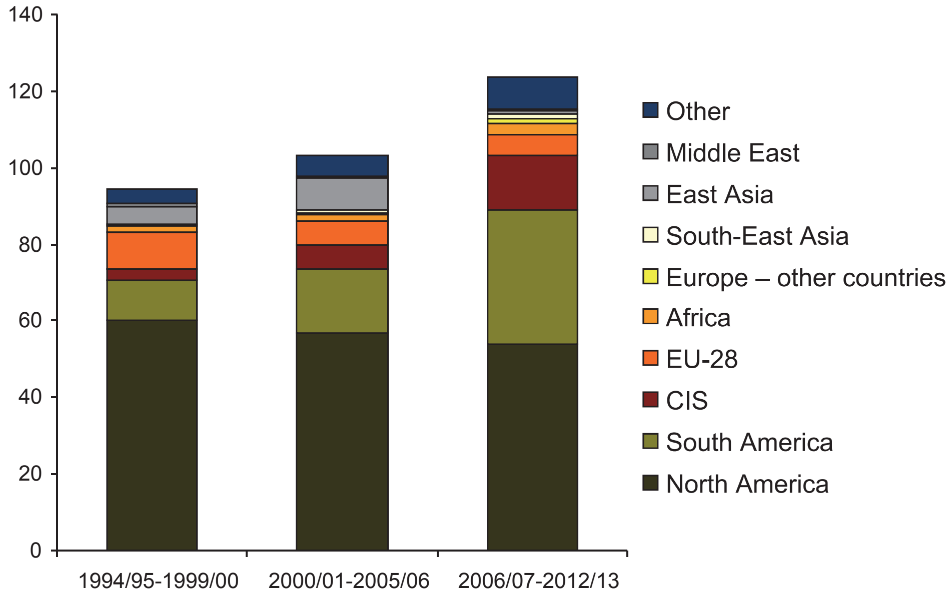
The turnover in export of **cereals for fodder** in the 1990s exceed 100 million tonnes. It reached the level slightly above 100 million tonnes in the first half of the previous decade. A clear increase in turnover of cereals for fodder has been observed from the season 2006/07 when it exceeded 110 million tonnes for the first time. Since then, it is at the average level above 120 million tonnes. The global markets deal mostly with maize trade. The significance of the remaining cereals for fodder is far smaller.

Table 2.13. Average annual export of wheat and cereals for fodder by regions (million tonnes)

Specification	1994/95- -1999/00	2000/01- -2005/06	2006/07- -2012/13	Dynamics in %		
	[1]	[2]	[3]	[2]/[1]	[3]/[2]	[3]/[1]
Wheat						
North America	48.724	43.192	47.798	88.6	110.7	98.1
CIS	6.496	14.858	28.480	228.7	191.7	438.4
EU-28	19.442	14.522	19.428	74.7	133.8	99.9
Oceania	14.766	15.065	15.455	102.0	102.6	104.7
South America	9.201	10.615	11.636	115.4	109.6	126.5
Middle East	2.463	2.822	4.034	114.6	143.0	163.8
East Asia	1.286	2.194	1.960	170.7	89.4	152.5
Africa	0.389	0.649	1.239	166.8	190.9	318.3
South-East Asia	0.419	0.454	0.727	108.3	160.2	173.5
Other	0.716	3.933	3.346	549.5	85.1	467.5
Total	**103.901**	**108.302**	**134.104**	**104.2**	**123.8**	**129.1**
Cereals for fodder						
North America	60.065	56.893	54.078	94.7	95.1	90.0
South America	10.742	16.483	34.975	153.4	212.2	325.6
CIS	2.570	6.654	14.299	258.9	214.9	556.3
EU-28	9.709	6.067	5.335	62.5	87.9	54.9
Africa	1.817	1.520	2.765	83.7	181.9	152.2
Europe – other countries	0.240	0.408	1.254	170.0	307.2	522.1
South-East Asia	0.303	0.813	1.230	268.5	151.3	406.1
East Asia	4.204	8.399	1.021	199.8	12.2	24.3
Middle East	0.998	0.589	0.316	59.0	53.6	31.6
Other	3.710	5.372	8.379	144.8	156.0	225.8
World in total	**94.358**	**103.197**	**123.651**	**109.4**	**119.8**	**131.0**

Source: own calculations on the basis of data from USDA.

Figure 2.10. Global export of cereals for fodder (million tonnes)



The market of cereals for fodder, just like the market of wheat, also experiences a significant degree of concentration of surpluses and thus export supply. North America (the USA) and South America (Argentina, Brazil) lead in this respect. The regularity observed on the market of wheat is also evident here – export from developing countries (the CIS, South America, South-East Asia) increases dynamically, and sales from developed countries decrease. As a result, the proportions of particular regions in the global turnover change. The share of North America and the EU is decreasing and the share of South America and South-East Asia is growing. However, the concentration of export supply increased in the examined period. The 5 largest exporters are currently delivering nearly 80% of the export supply (slightly more than 70% in the first half of the 1990s) and the proportion of the 10 largest exporters increased, accordingly, from more than 80% to more than 90%.

Table 2.14. Shares of particular regions of the world in export of wheat and cereals for fodder (%)

Specification	Share in %			Changes in percentage points		
	1994/95--1999/00 [1]	2000/01--2005/06 [2]	2006/07--2012/13 [3]	[2]-[1]	[3]-[2]	[3]-[1]
Wheat						
North America	46.9	39.9	35.6	7.0	-4.2	-11.3
CIS	6.3	13.7	21.2	7.5	7.5	15.0
EU	18.7	13.4	14.5	-5.3	1.1	-4.2
Oceania	14.2	13.9	11.5	-0.3	-2.4	-2.7
South America	8.9	9.8	8.7	0.9	-1.1	-0.2
Middle East	2.4	2.6	3.0	0.2	0.4	0.6
East Asia	1.2	2.0	1.5	0.8	-0.6	0.2
Africa	0.4	0.6	0.9	0.2	0.3	0.5
South-East Asia	0.4	0.4	0.5	0.0	0.1	0.1
Other	0.7	3.6	2.5	2.9	-1.1	1.8
Total	**100.0**	**100.0**	**100.0**	**x**	**x**	**x**
Cereals for fodder						
North America	63.7	55.1	43.7	-8.5	-11.4	-19.9
South America	11.4	16.0	28.3	4.6	12.3	16.9
CIS	2.7	6.4	11.6	3.7	5.1	8.8
EU-28	3.9	5.2	6.8	1.3	1.6	2.8
Africa	10.3	5.9	4.3	-4.4	-1.6	-6.0
Europe – other countries	1.9	1.5	2.2	- 0.5	0.8	0.3
South-East Asia	0.3	0.4	1.0	0.1	0.6	0.8
East Asia	0.3	0.8	1.0	0.5	0.2	0.7
Middle East	4.5	8.1	0.8	3.7	-7.3	-3.6
Other	1.1	0.6	0.3	- 0.5	-0.3	-0.8
Total	**100.0**	**100.0**	**100.0**	**x**	**x**	**x**

Source: own calculations on the basis of data from USDA.

Import

The demand for the import of wheat in the examined period indicated a clear upward trend. The largest deficit regions in the production of wheat, namely importer regions, include Africa, Asia and the Middle East. Relatively large quantities are also imported to South and North America, and to Europe, despite the fact that these regions are net exporters.

The demand for wheat increased in most regions. The CIS and East Asia were an exception. The highest growth was observed in the developing countries of Asia, Africa as well as in North America and Oceania. This explains the growing role of these regions in the structure of the global import demand which, as opposed to the structure of export demand, is more scattered. In other words, the shares of the largest importers in the market are much smaller than those of the largest exporters. In addition, the level of concentration of the demand for import decreased significantly in the examined period. The 5 and 10 largest importers accounted for, accordingly, more than 30% and more than 50% of shares at the beginning of this period. Their shares were reduced in the final stage of this period by approx. 10 percentage points.

Table 2.15. Average annual import of wheat and cereals for fodder by regions (million tonnes)

Specification	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	Dynamics in %		
	[1]	[2]	[3]	[2]/[1]	[3]/[2]	[3]/[1]
Wheat						
Africa	22.312	28.105	36.937	126.0	131.4	165.5
Middle East	13.685	12.645	19.549	92.4	154.6	142.9
South-East Asia	8.934	10.986	14.414	123.0	131.2	161.3
East Asia	16.907	13.876	13.772	82.1	99.3	81.5
South America	11.573	11.977	13.600	103.5	113.6	117.5
North America	4.668	5.885	7.220	126.1	122.7	154.7
CIS	7.488	5.229	6.429	69.8	123.0	85.9
EU	5.140	7.340	6.042	142.8	82.3	117.5
Oceania	0.464	0.707	0.831	152.3	117.6	179.1
Other	10.259	8.813	13.290	85.9	150.8	129.6
Total	**101.430**	**105.562**	**132.085**	**104.1**	**125.1**	**130.2**
Cereals for fodder						
East Asia	38.201	36.144	35.278	94.6	97.6	92.4
Middle East	12.452	16.512	20.894	132.6	126.5	167.8
North America	11.865	14.842	15.725	125.1	105.9	132.5
Africa	8.556	12.726	14.909	148.7	117.2	174.3
South America	6.810	6.807	10.768	100.0	158.2	158.1
EU-28	5.631	4.337	8.810	77.0	203.1	156.5
CIS	1.328	1.129	0.882	85.0	78.2	66.5
South-East Asia	0.074	0.034	0.139	46.2	409.7	189.1
Oceania	0.093	0.038	0.017	41.2	45.3	18.7
Other	7.195	8.817	11.804	122.5	133.9	164.1
Total	**92.203**	**101.387**	**119.227**	**110.0**	**117.6**	**129.3**

Source: own calculations on the basis of data from USDA.

The import of cereals for fodder also demonstrated a strong upward trend. As compared to the second half of the 1990s, it increased by nearly 30%. The import demand is mainly concentrated in East Asia, the Middle East and Africa. Large quantities are also imported to North America and South America.

The highest growth in import took place in South-East Asia, Africa, the Middle East as well as in the EU and South America. A contrary trend, was observed in East Asia and the CIS.

The structure of import demand for cereals for fodder is far more scattered. The demand of the 5 largest importer countries accounted for almost 21% of the import demand in the world, but it increased slightly in the examined period. However, it should be noted that the share of the 5 subsequent largest importers in terms of turnover is minute.

Table 2.16. Shares of respective regions in import of wheat and cereals for fodder by regions (%)

Specification	Share in %			Changes in percentage points		
	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	[2]-[1]	[3]-[2]	[3]-[1]
	[1]	[2]	[3]			
Wheat						
Africa	22.0	26.6	28.0	4.6	1.3	6.0
Middle East	13.5	12.0	14.8	-1.5	2.8	1.3
South-East Asia	8.8	10.4	10.9	1.6	0.5	2.1
East Asia	16.7	13.1	10.4	-3.5	-2.7	-6,2
South America	11.4	11.3	10.3	-0.1	-1.0	-1.1
North America	4.6	5.6	5.5	1.0	-0.1	0.9
CIS	7.4	5.0	4.9	-2.4	-0.1	-2.5
EU	5.1	7.0	4.6	1.9	-2.4	- 0.5
Oceania	0.5	0.7	0.6	0.2	0.0	0.2
Other	10.1	8.3	10.1	-1.8	1.7	-0.1
Total	**100.0**	**100.0**	**100.0**	**x**	**x**	**x**
Cereals for fodder						
East Asia	41.4	35.6	29.6	-5.8	-6.1	-11.8
Middle East	13.5	16.3	17.5	2.8	1.2	4.0
North America	12.9	14.6	13.2	1.8	-1.4	0.3
Africa	9.3	12.6	12.5	3.3	0.0	3.2
South America	7.4	6.7	9.0	-0.7	2.3	1.6
EU	6.1	4.3	7.4	-1.8	3.1	1.3
CIS	1.4	1.1	0.7	-0.3	-0.4	-0.7
South-East Asia	0.1	0.0	0.1	0.0	0.1	0.0
Oceania	0.1	0.0	0.0	-0.1	0.0	-0.1
Other	7.8	8.7	9.9	0.9	1.2	2.1
Total	**100.0**	**100.0**	**100.0**	**x**	**x**	**x**

Source: own calculations on the basis of data from USDA.

Figure 2.11. Global import of wheat (million tonnes)

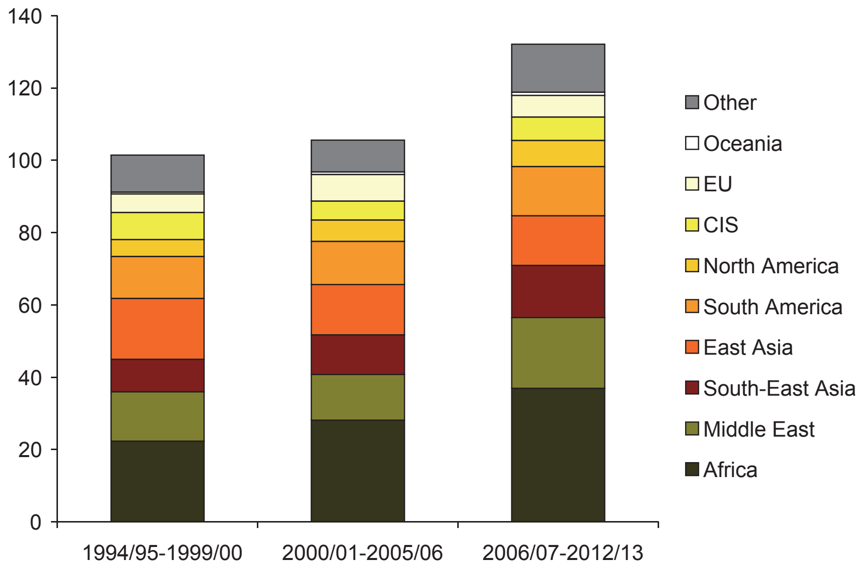
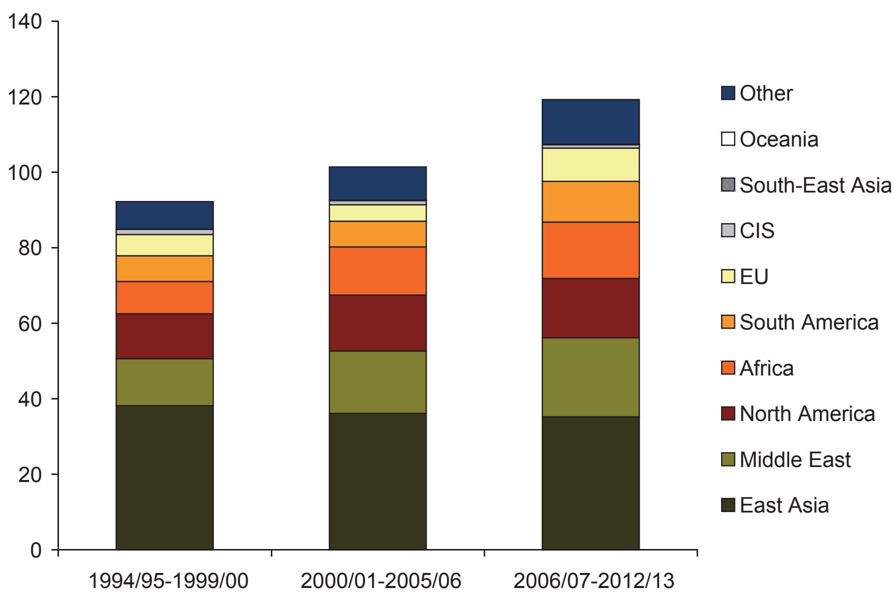


Figure 2.12. Global import of cereals for fodder (million tonnes)



The demand for cereals in many regions of the world increases along with the growth in the number of people and income. The significance of the international trade in cereals grows because of territorial differences between supply and demand for grain. The growth in the demand for grain is also accompanied by an increase in the area of cultivation and crops in countries which may be the source of surpluses due to climate. The import demand for typical food cereals is growing but the dynamics of the import demand for grain for fodder is higher. The role of developing countries will be more and more significant among importers of grain. This will be fostered by the growing number of people and, to a smaller extent, the level of income in these countries. The number of countries importing large quantities of grain is growing, but the number of countries with clear surpluses remains constant.

2.2. Sugar cane

Sugar cane (*Saccharum officinarum L.*) is classified into the group of six plants which changed the world along with tea, cotton, potatoes, coca bush and quina[4]. The processing of cane has a very long history because the beginnings of its cultivation in New Guinea date back to ca. 8000 BC[5]. The cultivation of cane in subsequent centuries spread across Polynesia and Asia (India, China), which is confirmed by the historical annals from the Asian expedition of Alexander the Great[6].

Sugar cane belongs to perennial plants and is a grass reaching up to 6 m. It is cultivated between 30°N and 30°S (Fig. 2.13). It requires a tropical or a subtropical climate with annual precipitation amounting to at least 600 mm/m^2, and good, hardly permeable soils. Sugar is obtained mainly from stems rich in juice in which the content of sucrose ranges from 13 to 20%. Harvest takes place usually twice a year. The remaining stems grow back, producing subsequent crops, but the next harvest is usually poorer. Two to ten harvests take place between each planting. Apart from production of sugar, sugar cane is also widely used in other branches of the economy such as production of rum, bioethanol as well as in the pharmaceutical industry, the paper industry (*bagasse*) and in the building industry.

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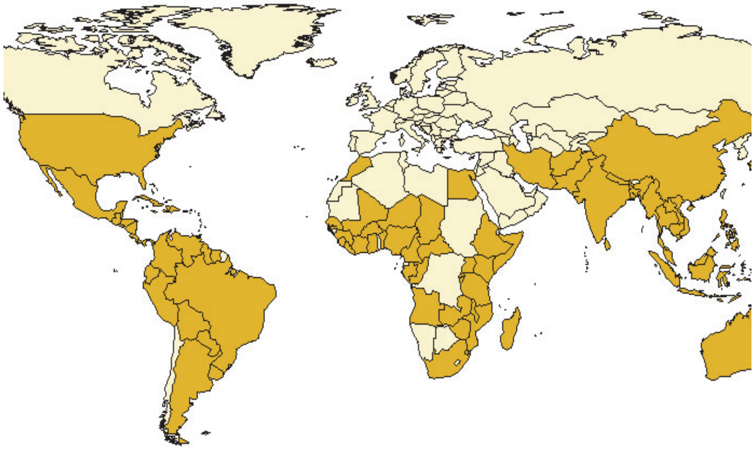
[4] Hobhouse H.: *Sechs Pflanzen verändern die Welt: Chinarinde, Zuckerrohr, Tee, Baumwolle, Kartoffel, Kokastrauch,* Klett-Cotta Verlag, Stuttgart 2001.
[5] Lippmann E.O.: *Die Geschichte des Zuckers, seiner Darstellung und Verwendung seit den ältesten Zeiten bis zum Beginne der Rübenzuckerfabrikation,* Max Hesse's Verlag, Leipzig1890.
[6] Łuczak C.: *Dzieje cukrownictwa w Polsce,* Adam Mickiewicz University, Poznań 1981.

Figure 2.13. Distribution of cultivations of sugar cane

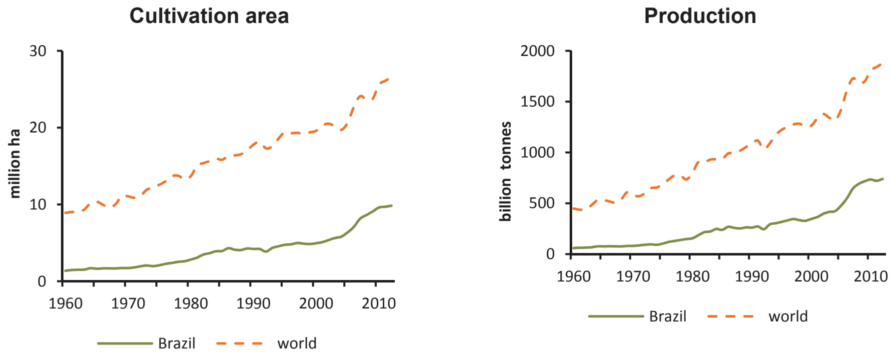


Source: prepared by the author on the basis of data from FAO.

The global area of sugar cane cultivation increases systematically, while the sowings of sugar beet decrease. The acreage of cultivation in 2012 amounted to 25.8 million ha and was by 1.6% higher than in the previous year (Fig. 2.14). The area for sowings of this plant increased within the last 50 years by an annual average of 2.1% (0.3 million ha). The dynamics in the last two decades was smaller than in 1961-1990. Cultivations were developing mainly in South-East Asia and in South America where they grew by 3.2-3.5% annually, and their current share in the structure of crops in these regions exceeds 80%. The acreage of cultivation in Brazil grew by 3.6% annually, and currently amounts to 9.4 million ha. The growth in cultivations in the initial period was determined by the growing consumption of sugar in the world. The development of technology and the possibilities to use sugar cane for the production of bioethanol, used in the fuel sector, also played an important role in the recent dozen or so years.

The share of sugar cane in the area of global arable lands increased in total from 0.7% to 1.8%, but they are currently very important for the agriculture and the economies of numerous countries in the inter-tropical climate zone. Sugar cane cultivation in the Caribbean countries (e.g. the Bahamas, Barbados, Martinique) and countries in south-east Africa (Swaziland), and on the islands in the south-west Indian Ocean (Mauritius, Reunion Islands) constitutes from 30% to more than 70% of crops in total.

Figure 2.14. Cultivation area and production of sugar cane



Source: prepared by the author on the basis of data from FAO.

The genetic progress in growing of varieties and in agrotechnics led to a growth in crops from approx. 50 t/ha on average in 1960s to 70 t/ha in the first half of the 21st century. The average annual dynamics of yielding amounted to approx. 0.6% annually. Crops, however, are definitely higher than the average in numerous countries and exceed 100 t/ha. When weather conditions are favourable and plantations are relatively young, crops amount to even 130 t/ha (Salvador, Peru, Colombia, Ethiopia). An increase in the fluctuations of yielding as a result of weather anomalies (too high precipitation, periodical droughts, increased presence of pests and ground frosts) has been observed in recent years. The consequence is the acceleration of works on the introduction of genetically modified (GMO) sugar cane to cultivations. It has a greater tolerance for water deficits, and a higher content of sugar. In 2013, Indonesia[7], as the first country in the world, approved the use of GMO cane varieties at the level of food security and environmental security thus making it possible to begin commercial cultivations in the nearest future. Field tests with the use of cane varieties resistant to herbicides and pests are also conducted in Brazil.

The growing acreage of cultivation and higher yielding resulted in the fact that the global harvest of sugar cane grew dynamically. In 1961-2012, harvest increased by 2.7% annually from the level of 0.4 billion tonnes to 1.8 billion tonnes. The largest producer is still Brazil where harvest in 2012 amounted to 0.7 billion tonnes and was almost two times higher than in the next country – India. The concentration of cultivation and harvests is proven by the 73% share of the 5 largest producers in the global supply of sugar cane (Tab. 2.17).

[7] *Indonesia. Agricultural Biotechnology Annual. Gain Report* – Global Agricultural Information Network, no ID 1338. USDA Foreign Agricultural Service, July 2013.

Sugar cane is also a raw material for the production of bioethanol which is used as a supplement to fuel. According to data from F.O. Licht, a German analytical company, bioethanol is mainly produced in Brazil. The use of sugar cane amounts to 0.21-0.25 billion tonnes which is approx. 96% of the global use of sugar cane for this purpose. Small quantities of bioethanol from sugar cane are also produced by Colombia which increased its processing from 1.6 million tonnes to 3.1 million tonnes in 2008-2013. The global use of sugar cane for the production of biofuels amounts to 0.26 billion tonnes which is approx. 15% of global crops.

The by-products of the production of sugar include molasses, beet pulp and bagasse. By-products are also used in the production of bioenergy because molasses from beet and cane is processed into bioethanol and part of the beet pulp is a raw material for the production of biogas. According to data from F.O. Licht, the global use of molasses for bioethanol grew from 14.6 million tonnes to 23.9 million tonnes in 2008-2013. The largest quantities of molasses are currently processed by Brazil (approx. 14 million tonnes), India (2.6 million tonnes) and Thailand (2.8 million tonnes).

The production of bioethanol from sugar beet plays a small role due to the high costs of their cultivation in Europe. The minimum buying price for sugar beet in the EU is EUR 26.3 per tonne. Small quantities of sugar beet for the production of bioethanol are cultivated in France and in the Czech Republic (763,000 tonnes), but buying prices offered to farmers in these countries are approx. EUR 24 per tonne. Income from cultivation at such a low level of prices is obtained only by the most effective farms which produce sugar beet under the most favourable soil and weather conditions.

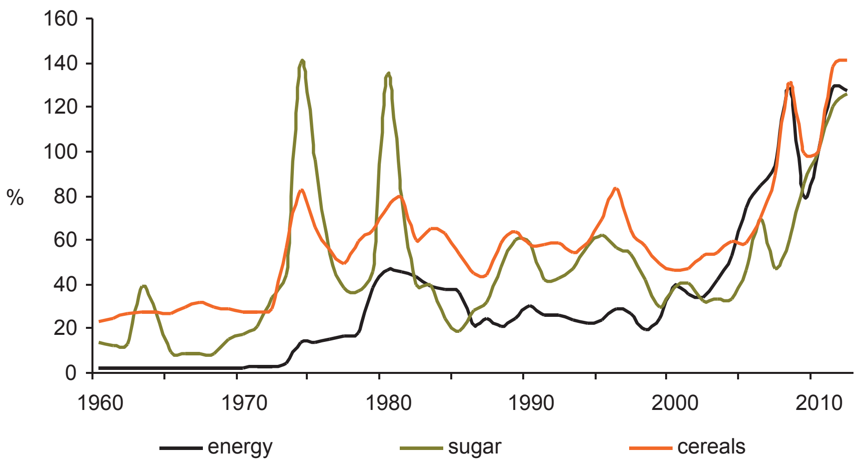
Table 2.17. Global production of sugar cane

Specification	Production in million tonnes			Relationships in %		
	1994--2000	2001--2006	2007--2012	[1]/[2]	[2]/[3]	[3]/[4]
	[1]	[2]	[3]			
World	**1221.6**	**1344.1**	**1716.7**	**110.0**	**127.7**	**140.5**
Brazil	321.6	403.7	668.1	125.5	165.5	207.7
China	70.9	87.5	116.9	123.4	133.6	164.8
India	279,0	272.1	328.5	97.5	120.7	117.8
Pakistan	47.6	48.2	55.2	101.3	114.5	116.0
Thailand	50.6	57.7	77.7	114.0	134.6	153.5

Source: prepared by the author on the basis of data from FAO.

The prices of raw sugar and white sugar are strongly correlated with the prices of energy carriers. The graphic presentation of global price indexes of sugar and energy, published by the World Bank, indicates a clear cointegration which means that short-term disturbances may take place between the prices of compared products but balance is kept between them in the long-term. Brazil, the largest global producer and exporter of sugar, allocates large quantities of sugar cane for the production of bioethanol in the years of high global prices of energy carriers. As a consequence, the supply on the global market is smaller and sugar prices grow. In recent years there is a stronger convergence of sugar prices with the prices of energy carriers than in previous years (Fig. 2.15).

Figure 2.15. Indexes of global prices of energy, sugar and cereals (2010=100)



Source: prepared by the author on the basis of data from FAO.

2.3. Oilseeds

2.3.1. Production

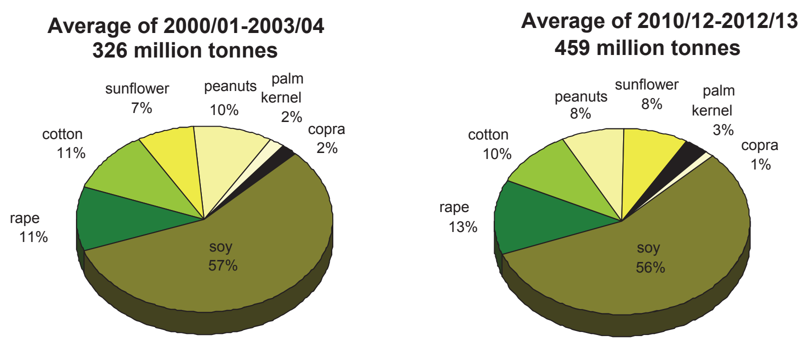
The basic raw materials used for the production of self-contained biofuels (replacing diesel oil in 100%), which may be used in adequately built diesel engines or for the production of biocomponents added in various proportions to diesel oil, include vegetable oils produced by pressing and the extraction of seeds, and fruit of oilseeds. Vegetable oils obtained from the seeds of soybean, rapeseed and the African oil palm currently have the widest application in the production of biofuels of the first generation used in diesel engines (namely produced from agricultural raw materials which may be used as food). Thus, when discussing the global market of oilseed raw materials in the context of the production of biofuels, the focus is mostly on the issues of production, consumption and trade in the seeds referred to above as well as fruit of oilseeds and vegetable oils obtained as a result of their processing.

Oilseeds

The most important oilseeds, the seeds and fruit of which provide approx. 95% of the global production of vegetable fats, include: soybean, rapeseed, cotton, sunflower, peanuts, sesame, flax and the castor oil plant, cultivated as annual field crops, as well as trees such as: the African oil palm, the coconut palm and the olive tree, grown on perennial plantations. The oilseeds referred to above play a very significant role in the global agriculture, the food economy and processing industries. They are a raw material for the production of consumer and technical fats, they are the source of food and fodder protein and some of them, like cotton and flax, also provide vegetable fibres.

Soybean has the greatest share in the global production of seeds and fruit of the 7 major oilseeds (56% on average in 2010/11-2012/13). Further places are occupied by: **rapeseed** (13%), **cotton** (10%), **peanuts** (9%), **sunflower** (8%), **palm kernel** (3%) and **copra** (1%).

Figure 2.16. Structure of global production of oilseeds



Source: prepared by the author on the basis of data from USDA.

Cultivations of oilseeds are characterized by substantial concentration, especially in the case of soybean, rapeseed as well as the African oil palm. More than 80% of the global production of soybean comes from in the USA, Brazil and Argentina and almost 90% of the global production of rapeseed – from the EU, China, Canada and India. Global plantations of the African oil palm are concentrated almost in 90% in Malaysia and Indonesia. Approximately 70% of the global production of sunflower seeds comes from: the EU, Ukraine, Russia and Argentina. China and India account for approx. 60% of the global production of peanuts, while China, India and Pakistan account for approx. 60% of the global production of cotton.

Table 2.18. Global balance of oilseeds (million tonnes)

Years	Production	Resources in total	Import	Export	Consumption	Closing stocks
2000/01	316.1	354.7	65.6	66.9	313.0	40.4
2001/02	326.8	367.2	63.6	62.4	325.7	42.9
2002/03	334.4	377.3	71.0	70.0	328.6	49.6
2003/04	338.2	387.8	64.2	66.8	338.6	46.5
2004/05	383.7	430.2	72.7	74.4	368.5	60.0
2005/06	394.1	454.1	75.4	75.8	387.0	66.7
2006/07	405.7	472.4	80.7	83.1	394.4	75.6
2007/08	392.1	467.7	90.1	91.3	402.6	63.8
2008/09	398.8	462.6	93.9	94.6	403.4	58.6
2009/10	446.8	505.3	101.8	106.9	423.7	76.5
2010/11	460.1	536.6	103.8	108.3	446.7	85.4
2011/12	444.6	529.9	111.6	111.5	464.6	65.4
2012/13	472.6	538.0	111.7	115.0	465.1	69.7
2013/1[a]	495.1	564.8	121.6	125.8	479.4	81.2

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

The global harvest of oilseeds has been systematically growing from the beginning of the 21st century. It decreased only in the season 2007/08 when the crops and acreage of cultivations of oilseeds, mainly soybean and sunflower, were reduced because of unfavourable weather conditions which occurred in numerous regions of the world. The demand for food and renewable energy is growing on the global scale. The improvement in the condition of nutrition, among societies with the growing number of people, as well as the development of production of biofuels increases the demand for vegetable oils. The development of animal production with the use of modern technologies of animal nutrition increases the demand for oil meals. The demand for oil meals grew in recent years also because of the crisis related to BSE and the introduction of the ban on using meat and bone meal in feeding farm animals in numerous countries.

The global harvest of oilseeds grew in 2000/01-2012/13 by 50% (from 316 million tonnes to 473 million tonnes), as a result of the increase in the area of cultivations by 25% (from 190 million ha to 238 million ha), and crops by

19% (from 1.66 t/ha to 1.98 t/ha). It increased more than twice as compared to the beginning of the 1990s. Its further growth to 495 million tonnes is expected in the season 2013/14. The highest growth in the production of oilseeds in the last twelve years was recorded in Brazil (two times), India (by 89%), Argentina (by 73%) and the EU-27 (by 61%). Harvest in the USA increased slightly as compared to the countries referred to above, only by 9%.

However, the USA still occupies a key position in the global production of oilseeds, although its share in this production dropped (from 27% in the season 2000/01 to 20% in the season 2012/13) and further places are occupied by Brazil (18%), China (13%) and Argentina (11%). Despite a large growth in the production of oilseeds in India and in the EU, their shares in the global production of oilseeds remain small (accordingly, 8% and 6% in the season 2012/13).

Soybean

The global production of soybean increases dynamically. Its harvest increased in 2000/01-2012/13 by 52% (from 176 million tonnes to 268 million tonnes) as a result of the increase in the area of cultivations by 44% (from 75 million ha to 109 million ha) and crops by 6% (from 2.33 t/ha to 2.46 t/ha), and it grew more than twice as compared to the beginning of the 1990s. A further growth in the production of soybean to 282 million tonnes is forecasted in the season 2013/14.

The USA is the largest global producer of soybean. However, after 2000 the production of soybean in the USA was growing slowly due to the deterioration of the profitability of its production as compared to maize which became a sought-after raw material used in the production of bioethanol on the American market. Soybean and maize are generally cultivated in the same areas because their soil and climate requirements are similar. The harvest of soybean in the USA in 2009/10 and 2010/11 exceeded 90 million tonnes and was by 20% higher than at the beginning of the decade, but it decreased in the next two seasons to 82-84 million tonnes. On the other hand, the production of soybean grows very dynamically in South American countries, mainly as a result of a large expansion in the acreage of its cultivation. The harvest of soybean in Brazil in the last twelve years increased twice (to 82 million tonnes in the season 2012/13), in Argentina by 78% (to 49 million tonnes) and in Paraguay – almost three times (to 9 million tonnes). The production of soybean in India also increased more than twice (to less than 12 million tonnes). On the contrary, the production of soybean in China did not change substantially. It was kept at the level of 15 million tonnes with minor exceptions.

The USA remains the leader in the global production of soybean but its share in this production decreased from 43% in the season 2000/01 to 31% in the season 2012/13. On the other hand, the share of Brazil (accordingly, from 22 % to 31%) and Argentina (from 16% to 18%) increased. The fourth place in the global production of soybean is occupied by China, while its share in this production dropped (from 9% to 5%). The share of India (from 3% to 4%) and Paraguay (from 2% to 3%) increased. The further expansion in the production of soybean in Brazil and Argentina will strengthen the position of South America in the global production of soybean. The total production of soybean in Brazil and Argentina is higher than that of the USA in the season 2002/03. This difference increased from 13 million tonnes in the season 2002/03 to 49 million tonnes in the season 2012/13. The production of soybean in Brazil grew in the last season to 82 million tonnes and was slightly lower than that in the USA.

Table 2.19. Global balance of soybean (million tonnes)

Years	Production	Resources in total	Import	Export	Consump-tion	Closing stocks
2000/01	175.8	205.9	53.1	53.8	171.5	33.7
2001/02	184.8	218.5	54.4	53.0	184.3	35.6
2002/03	196.9	232.5	62.9	61.3	191.1	43.0
2003/04	186.6	229.7	54.1	56.1	188.9	38.8
2004/05	215.7	254.5	63.5	64.8	204.0	49.2
2005/06	220.7	269.9	64.1	63.9	215.8	54.4
2006/07	236.1	290.5	69.0	71.1	224.6	63.7
2007/08	219.6	283.2	78.4	78.3	229.8	53.5
2008/09	211.6	265.1	77.4	77.2	221.2	44.1
2009/10	260.4	304.5	86.9	91.4	237.7	62.2
2010/11	263.9	326.1	88.7	91.7	251.5	71.7
2011/12	239.2	310.9	93.2	92.3	256.9	54.9
2012/13	267.5	322.4	94.8	97.7	257.9	61.6
2013/14[a]	281.7	343.2	104.5	107.3	268.9	71.5

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Taking into account the high share of soybean in the global production of oilseeds and a very high degree of concentration of its production, the fluctuations of crops of the largest producers and exporters of soybean, namely the USA, Brazil and Argentina, have a significant impact on price formation on the global market of oilseeds and products of their processing.

Table 2.20. Production of soybean by countries (million tonnes)

Years	World	USA	Brazil	Argentina	China	India	Paraguay	Other countries
2000/01	175.8	75.1	39.5	27.8	15.4	5.3	3.5	9.3
2001/02	184.7	78.7	43.5	30.0	15.4	5.4	3.6	8.2
2002/03	198.0	75.0	52.0	35.5	16.5	4.0	4.5	10.5
2003/04	187.2	66.8	51.0	33.0	15.4	6.8	3.9	10.3
2004/05	215.7	85.0	53.0	39.0	17.4	5.9	4.0	11.4
2005/06	220.6	83.5	57.0	40.5	16.4	7.0	3.6	12.6
2006/07	236.2	87.0	59.0	48.8	15.1	7.7	5.9	12.8
2007/08	220.4	72.9	61.0	46.2	13.4	9.5	6.9	10.6
2008/09	212.0	80.8	57.8	32.0	15.5	9.1	4.0	12.8
2009/10	260.4	91.4	69.0	54.5	15.0	9.7	6.5	14.3
2010/11	263.9	90.6	75.3	49.0	15.1	9.8	7.1	17.0
2011/12	239.2	84.2	66.5	40.1	14.5	11.0	4.0	18.8
2012/13	267.5	82.1	82.0	49.4	12.8	11.5	9.4	20.4
2013/14[a]	281.7	85.7	88.0	53.5	12.2	12.3	9.0	21.0

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Rapeseed

The global harvest of rapeseed in 2000/01-2012/13 was characterized by a strong upward trend. It increased over this period by 68% (from 37 million ha to 63 million tonnes) as a result of the increase in the area of cultivations by 45% (from 25 million ha to 36 million ha), and crops by 16% (from 1.51 t/ha to 1.75 t/ha) and it grew more than two times and a half as compared to the beginning of the 1990s. A further growth in the production of rapeseed to 67 million tonnes is forecasted in the season 2013/14. The average annual growth rate in the production of rapeseed in 2000/01-2012/13 amounted to 4.4% as compared to 3.6% in the case of soybean, and 3.8% in the case of sunflower seeds.

The EU is the leader in the global production of rapeseed. Despite a high level already at the beginning of the previous decade, the production of rapeseed in the EU countries was increasing rapidly, mainly because of the dynamic growth in the production of biodiesel in Europe. As a result, the demand for rapeseed oil used in the production of esters grew, as well. The harvest of rapeseed in the EU in two last seasons amounted to 19 million tonnes and was more than 70% higher than at the beginning of the decade.

Starting from the season 2008/09, the second place in the global production of rapeseed is occupied alternately by China and Canada. The production of rapeseed in China in the last twelve years was quite stable and fluctuated to a small extent from 11 million tonnes to 14 million tonnes, while in it grew dynamically in Canada, where it increased from 7 million tonnes, at the beginning of the previous decade, to 14 million tonnes in the season 2012/13. A significant increase was also recorded in the harvest in India (by 79% to 7 million tonnes) and Australia (more than twice to 4 million tonnes). Ukraine joined the group of large producers in the previous decade. The harvest of rapeseed in Ukraine in the first half of the previous decade amounted to only several hundred tonnes and it exceeds 1 million tonnes from the season 2007/08. The highest harvest, reaching almost 3 million tonnes was recorded in the season 2008/09.

The share of the EU in the global production of rapeseed in 2000/01--2012/13 ranged from 31% to 38%, except for the season 2003/04 when it reached the level below 30%. The share of China in the global production of rapeseed decreased from 31%, at the beginning of the previous decade, to 22% in two recent seasons and is now similar to Canada's share. The share of Canada in the global production of rapeseed decreased from 20% in the season 2000/01 to 14% in two following seasons and then it grew systematically to 22-24% in two recent seasons.

Table 2.21. Global balance of rapeseed (million tonnes)

Years	Production	Resources in total	Import	Export	Consumption	Closing stocks
2000/01	37.4	41.6	7.0	7.2	38.7	2.7
2001/02	36.0	38.7	5.0	4.9	35.9	2.9
2002/03	33.3	36.1	4.0	4.1	33.8	2.2
2003/04	39.5	41.7	5.1	5.5	38.9	2.4
2004/05	46.1	48.5	5.0	4.9	43.3	5.3
2005/06	48.6	53.9	6.7	7.0	47.8	5.8
2006/07	45.2	51.0	7.0	6.6	46.2	5.1
2007/08	48.6	53.6	7.5	8.2	49.0	4.0
2008/09	57.9	61.9	12.1	12.1	54.6	7.3
2009/10	61.1	68.3	10.8	10.8	59.4	8.9
2010/11	60.6	69.5	10.1	10.9	61.5	7.2
2011/12	61.2	68.4	13.2	12.9	63.8	4.9
2012/13	62.9	67.8	12.4	12.1	65.2	2.9
2013/14[a]	66.5	69.4	12.2	12.7	65.3	3.6

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Table 2.22. Production of rapeseed by countries (million tonnes)

Years	World	EU--25/27	Canada	China	India	Australia	Ukraine	Other countries
2000/01	37.4	11.3	7.4	11.4	3.8	1.8	0.1	1.6
2001/02	36.0	11.5	5.1	11.3	4.5	1.8	0.1	1.7
2002/03	33.3	11.7	4.7	10.6	4.1	0.9	0.1	1.4
2003/04	39.5	11.2	7.0	11.4	6.8	1.7	0.1	1.2
2004/05	46.1	15.4	8.0	13.2	6.5	1.5	0.3	1.2
2005/06	48.6	15.5	9.7	13.1	7.0	1.4	0.3	1.6
2006/07	45.2	16.1	9.0	11.0	5.8	0.6	0.6	2.1
2007/08	48.6	18.4	9.6	10.6	5.5	1.1	1.1	2.5
2008/09	57.9	19.0	12.6	12.1	6.7	1.9	2.9	2.7
2009/10	61.1	21.6	12.4	13.7	6.4	1.9	1.9	3.2
2010/11	60,6	20.3	11.9	12.8	7.0	2.1	1.5	5.1
2011/12	61.2	19.2	14.6	13.4	6.2	3.4	1.4	2.9
2012/13	62.9	19.2	13.9	14.0	6.8	4.3	1.3	3.4
2013/14[a]	66.5	20.7	15.2	14.2	7.0	3.6	2.4	3.4

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

African oil palm

The African oil palm is cultivated only in the tropical climate zone. Its fruit give two kinds of fats, differing in appearance and chemical composition, namely: palm oil, which is obtained from the pericarp surrounding the stone with the seed inside, and oil from palm kernels. The global area of the African oil palm plantations doubled in 2000-2013 (an increase from 7.4 million ha to 14.8 million ha) and the productivity of plantations, measured by the yield of oil palm from 1 ha of the plantation, increased by 18% (from 3.25 t/ha to 3.82 t/ha). The largest area of the African oil palm cultivations is in South-East Asian countries, mainly, in Malaysia and Indonesia. In 2000-2013, the acreage of the African oil palm cultivation in Indonesia increased 3.1 times (from 2.2 million ha to 6.9 million ha) and in Malaysia it increased by 52% (from 2.9 million ha to 4.4 million ha). At the same time, the productivity of plantations of the African oil palm increased more in Indonesia than in Malaysia. As a result, the share of Indonesia in the global production of oil palm increased (from 34% in 2000 to 51% in the season 2013) and the share of Malaysia decreased but is still high (accordingly, from 49% to 34%). The total share of Indonesia and Malaysia in the global production of oil palm increased from 83% at the beginning of the previous decade to 85% in the last two years.

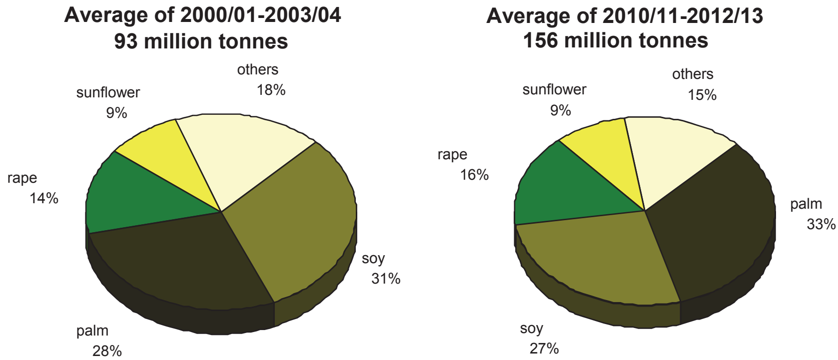
Steps towards the development of the African oil palm plantations in Thailand, Nigeria and Colombia were also taken in the last decade. However, the total share of those countries in the global production of oil palm still remains at the level below 10%.

Vegetable oils

Soybean dominates in the global acreage of cultivation and production of seeds and fruit from oilseeds. However, **palm oil** dominates in the global production of vegetable oils because of the much higher content of fats in fruits of the African oil palm (approx. 70%) than in soybean seeds (approx. 18%), and a significantly higher yield from 1 ha of the African oil palm cultivation (3.7 t/ha on average in 2009-2013) than soybean cultivation (0.4 t/ha). Palm oil is still strengthening its position (33% of share on average in 2010/11-2012/13). Subsequent places in this production are occupied by: **soybean oil** (27%), **rapeseed oil** (16%) and **sunflower oil** (9%).

As in the global production of oilseeds, the global production of vegetable oils has experienced a long-term upward trend which was increasingly created by the dynamically growing demand for oils from the biofuel sector from the beginning of the 2000s. In 2000/01-2012/13, the global production of the 8 most important vegetable oils (palm oil, soybean oil, rapeseed oil, sunflower oil, palm kernel oil, cotton oil, peanut oil and coconut oil) along with olive oil increased by 78% (from 90 million tonnes to 160 million tonnes) and it grew almost three times as compared to the beginning of the 1990s. Its further increase to 167 million tonnes is expected in the season 2013/14. The production of oils from fruit of the African oil palm increased the most in the last twelve years: oil palm 2.3 times (from 24 million tonnes to 55 million tonnes) and oil from palm seeds 2.1 times (from 3 million tonnes to 6 million tonnes). The production of rapeseed oil increased by 85% (from 13 million tonnes to 25 million tonnes), soybean oil by 60% (from 27 million tonnes to 44 million tonnes) and sunflower oil by 70% (from 8 million tonnes to 14 million tonnes).

Figure 2.17. Structure of global production of vegetable oils



Other oils: palm kernel oil, cotton oil, peanut oil, coconut oil and olive oil.

Source: prepared by the author on the basis of data from USDA.

The increasing dynamics of the production of vegetable oils as compared to oilseeds from which they are obtained, present in recent years, results from an increase in the content of fats in new, refined varieties of oilseeds and the use of more and more efficient methods of oil pressing and extraction.

The production of vegetable oils was growing dynamically in all regions of the world, while it increased most rapidly in Asian countries. The average annual growth rate of vegetable oils in the world in 2000/01-2012/13 amounted to almost 5%, while it exceeded 10% in Indonesia, 6% in China, amounted to 4% in Brazil and Malaysia, and 3% in the EU and Argentina. The production of oils in India (1% annually) and the USA (below 1% annually) grew in the slowest manner.

The largest producers of vegetable oils are Asian countries. The total share of Indonesia, Malaysia and China in this production increased from 38% in the season 2000/01 to 48% in the season 2012/13. Indonesia has been the leader in the global production of vegetable oils starting from the season 2005/06 (the first place was previously occupied by Malaysia). The share of Indonesia in the global production of vegetable oils is growing systematically – from 11% in the season 2000/01 to 20% in the season 2012/13. The second place in the global production of oils in the last two seasons was occupied by China (13-14% of the share), the third place – by Malaysia (13% of the share), and the fourth place – by the EU (more than 10% of the share).

Table 2.23. Global balance of vegetable oils (million tonnes)

Years	Production	Resources in total	Import	Export	Consumption	including: for food purposes	Closing stocks
2000/01	90.0	99.7	30.2	30.8	88.4	78.3	10.6
2001/02	93.0	103.6	30.8	32.9	91.2	80.3	10.3
2002/03	96.3	106.6	34.9	36.0	95.4	83.2	10.1
2003/04	103.1	113.2	37.7	39.2	101.2	87.2	10.5
2004/05	111.8	122.3	40.8	42.7	108.3	91.7	12.1
2005/06	119.3	131.3	44.5	47.6	115.1	94.8	13.1
2006/07	122.0	135.1	47.3	49.1	120.3	96.8	13.0
2007/08	129.0	142.1	50.7	53.7	126.7	100.1	12.4
2008/09	134.2	146.5	54.5	55.8	131.6	103.5	13.6
2009/10	141.4	155.0	56.1	57.5	139.7	108.2	14.0
2010/11	149.0	163.0	57.7	59.7	146.3	111.8	14.6
2011/12	157.4	172.1	61.6	63.4	152.5	115.7	17.7
2012/13	160.4	178.1	64.6	66.1	157.4	120.2	19.3
2013/14[a]	167.3	186.6	66.5	68.7	163.2	124.2	21.2

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Palm oil

The global production of oils from fruit of the African oil palm in 2000/01-2012/13 has grown the most from among all vegetable oils: oil palm 2.3 times (from 24 million tonnes in the season 2000/01 to 55 million tonnes in the season 2012/13), and palm kernel oil 2.1 times (from 3 million tonnes to 6 million tonnes).

Indonesia and Malaysia are the leaders in the global production of oil palm. Its production in Indonesia in the last twelve years increased 3.4 times (to 29 million tonnes in the season 2012/13) and in Malaysia – 1.6 times (to 19 million tonnes). In Thailand it increased 3.3 times (to 2 million tonnes), in Colombia by 63% (to 0.9 million tonnes) and in Nigeria by 20% (to 0.9 million tonnes).

The share of Indonesia in the global production of oil palm increased as a result of these changes from 34% in the season 2000/01 to 52% in the season 2012/13, and the share of Malaysia decreased but still remains high (accordingly, from 49% to 34%). The total share of Indonesia and Malaysia in the global production of oil palm in the discussed period thus increased from 83% to 86%, while the total share of Thailand, Nigeria and Colombia stayed below 10%.

Table 2.24. Global balance of oil palm (million tonnes)

Years	Produc-tion	Re-sources in total	Import	Export	Con-sumption	including: for food purposes	Closing stocks
2000/01	24.2	27.5	16.3	16.5	23.7	19.8	3.6
2001/02	25.3	28.9	16.5	17.6	24.4	20.0	3.4
2002/03	27.7	31.1	19.7	19.9	27.3	21.9	3.5
2003/04	30.0	33.5	21.9	22.1	29.1	23.0	4.2
2004/05	33.5	37.6	24.3	25.0	32.3	24.8	4.7
2005/06	35.8	40.4	26.1	27.3	34.4	26.0	4.8
2006/07	37.4	42.2	26.9	27.6	36.4	27.4	5.1
2007/08	41.1	46.3	30.7	32.2	40.4	30.3	4.4
2008/09	44.1	48.5	34.1	34.7	43.0	32.1	4.9
2009/10	46.0	50.9	35.2	35.5	45.1	33.6	5.5
2010/11	48.8	54.3	36.3	36.9	47.8	34.8	5.9
2011/12	51.9	57.8	38.7	39.0	50.6	36.5	6.9
2012/13	55.3	62.2	41.2	41.8	53.7	38.8	7.9
2013/14[a]	58.1	66.0	42.4	43.0	56.2	40.6	9.2

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Table 2.25. Production of oil palm by countries (million tonnes)

Years	World	Indonesia	Malaysia	Thailand	Nigeria	Columbia	Other countries
2000/01	24.2	8.3	11.9	0.6	0.8	0.6	2.2
2001/02	25.3	9.2	11.9	0.6	0.8	0.5	2.4
2002/03	27.7	10.3	13.2	0.6	0.8	0.5	2.3
2003/04	30.0	12.0	13.4	0.8	0.8	0.6	2.4
2004/05	33.5	13.6	15.2	0.8	0.8	0.7	2.5
2005/06	35.8	15.6	15.5	0.8	0.8	0.7	2.5
2006/07	37.4	16.6	15.3	1.2	0.8	0.8	2.7
2007/08	41.1	18.0	17.6	1.1	0.8	0.8	2.9
2008/09	44.0	20.5	17.3	1.5	0.9	0.8	3.1
2009/10	46.0	22.0	17.8	1.3	0.9	0.8	3.3
2010/11	48.8	23.6	18.2	1.8	0.9	0.8	3.5
2011/12	51.9	26.2	18.2	1.9	0.9	0.9	3.8
2012/13	55.3	28.5	19.0	2.0	0.9	0.9	3.9
2013/14[a]	58.1	31.0	19.0	2.1	0.9	0.9	4.1

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Soybean oil

The global production of soybean oil grew in 2000/01-2012/13 by 59% (from 27 million tonnes to 43 million tonnes). It increased the most in the group of key producers: China (over 3.5 times to 12 million tonnes in the season 2012/13), in Argentina (by 99% to 6 million tonnes) and in Brazil (by 57% to 7 million tonnes). It stayed at the level of 8-9 million tonnes in the USA. It decreased by 23% (to 2.3 million tonnes) in the EU-27 and it doubled in India (to 1.7 million tonnes).

Table 2.26. Global balance of soybean oil (million tonnes)

Years	Production	Resources in total	Import	Export	Consump-tion	Closing stocks
2000/01	26.8	29.6	6.8	6.9	26.5	3.1
2001/02	29.0	32.1	7.6	8.3	28.1	3.3
2002/03	30.6	33.8	8.2	8.8	30.1	3.1
2003/04	30.3	33.4	8.4	8.7	30.3	2.8
2004/05	32.5	35.3	8.9	9.1	31.8	3.3
2005/06	34.9	38.2	9.1	9.8	33.5	3.9
2006/07	36.4	40.3	10.0	10.5	35.7	4.1
2007/08	37.8	41.8	10.4	10.8	37.7	3.7
2008/09	35.9	39.5	9.1	9.1	36.3	3.2
2009/10	38.8	42.0	8.7	9.1	38.2	3.3
2010/11	41.3	44.6	9.4	9.6	40.7	3.7
2011/12	42.6	46.3	8.0	8.5	41.9	3.9
2012/13	42.7	46.6	8.6	8.9	42.6	3.8
2013/14[a]	44.4	48.2	8.8	9.0	44.3	3.6

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Table 2.27. Production of soybean oil by countries (million tonnes)

Years	World	China	USA	Brazil	Argenti-na	EU--25/27	India	Other countries
2000/01	26.8	3.2	8.4	4.3	3.2	3.0	0.8	4.0
2001/02	29.0	3.6	8.6	4.6	3.9	3.2	0.9	4.3
2002/03	30.6	4.7	8.4	5.2	4.4	2.9	0.6	4.3
2003/04	30.3	4.5	7.8	5.6	4.7	2.5	1.0	4.1
2004/05	32.5	5.4	8.8	5.6	5.1	2.6	0.9	4.1
2005/06	34.9	6.2	9.3	5.4	6.0	2.5	1.1	4.5
2006/07	36.4	6.4	9.3	6.0	6.4	2.6	1.2	4.5
2007/08	37.8	7.1	9.3	6.2	6.6	2.7	1.5	4.4
2008/09	35.9	7.3	8.5	6,1	5.9	2.3	1.3	4.4
2009/10	38.8	8.7	8.9	6.5	6.5	2.3	1.3	4.6
2010/11	41.3	9.8	8.6	7.0	7.2	2.2	1.7	4.8
2011/12	42.6	10.9	9.0	7.3	6.8	2.2	1.7	4.6
2012/13	42.7	11.6	9.0	6.7	6.3	2.3	1.7	5.1
2013/14[a]	44.4	12.2	8.6	7.1	7.1	2.2	1.8	5.3

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

The share of China in the global production of soybean oil increased from 12% at the beginning of the 2000s to 27% in the season 2012/13, while the share of the USA decreased at that time from 31% to 21%. As of the season 2010/11, the USA lost the first position in the global production of soybean oil to China. The share of Argentina in the global production of soybean oil was growing systematically in the last twelve years (from 12% in the season 2000/01 to 15% in the season 2012/13). In 2005/06-2010/11, Argentina became the third largest producer of this oil. The share of Brazil stayed at the level of 16-18%, while the share of the EU in the global production of soybean oil decreased from 11% at the beginning of the past decade to 5% in the last two seasons.

Rapeseed oil

The global production of rapeseed oil in 2000/01-2012/13 increased by 85% (from 13 million tonnes to 25 million tonnes), namely more than soybean oil.

The EU is the leader in the global production of rapeseed and rapeseed oil. The production of rapeseed oil in the EU countries was increasing rapidly in 2000/01-2012/13 despite a high level already at the beginning of the past decade, mainly due to the dynamic growth in the biofuel sector. In the season 2009/10, the production of rapeseed oil in the EU for the first time exceeded 9 million tonnes and was more than twice as large as at the beginning of the previous decade. It stayed at a similar level in the following three seasons. China, which occupies the second position in the global production of rapeseed oil, has been experiencing a growth in its production starting from the season 2008/09 after several years of stagnation (from 4.7 million tonnes in the season 2000/01 to 6 million tonnes in the season 2012/13). The third place in the global production of rapeseed oil is occupied by India, while it lost this position to Canada twice in the last three seasons. The production of rapeseed oil in India increased by 45% (from 1.6 million tonnes in the season 2000/01 to 2.3 million tonnes in the season 2012/13) and it increased in Canada 2.4 times (from 1.2 million tonnes to 2.9 million tonnes).

The EU strengthened the leading position in the global production of both rapeseed and rapeseed oil in the analysed years. Its share in the global production of rapeseed oil increased from 31% in the season 2000/01 to 38% in the season 2012/13, and it even exceeded 40% in 2008/10-2010/12. An opposite situation took place in the case of China. The share of China in the global production of rapeseed oil decreased from 35% at the beginning of the past decade to 25% in the last season. The share of Canada in the global production of rapeseed oil stayed at the level of 7-9% for many years and it increased to 10-13%

in the last three seasons. The share of India decreased from 12% at the beginning of the previous decade to 9% in the last season.

Table 2.28. Global balance of rapeseed oil (million tonnes)

Years	Production	Resources in total	Import	Export	Consumption	including: for food purposes	Closing stocks
2000/01	13.4	14.1	1.3	1.2	13.4	12.3	0.8
2001/02	13.1	13.9	1.1	1.0	13.3	12.1	0.7
2002/03	12.3	13.0	0.9	0.9	12.4	11.1	0.6
2003/04	14.2	14.7	1.4	1.3	14.4	12.5	0.4
2004/05	15.8	16.2	1.2	1.3	15.6	12.9	0.5
2005/06	17.5	18.0	1.5	1.7	17.1	13.2	0.7
2006/07	17.2	18.0	2.2	2.0	17.6	12.7	0.6
2007/08	18.5	19.0	2.0	1.9	18.3	13.1	0.9
2008/09	20.6	21.5	2.4	2.4	20.3	14.2	1.2
2009/10	22.6	23.7	2.9	2.7	22.6	15.2	1.3
2010/11	23.5	24.8	3.3	3.4	23.5	16.2	1.2
2011/12	24.3	25.4	4.0	4.0	23.8	16.4	1.7
2012/13	24.7	26.4	3.8	4.0	23.5	16.3	2.8
2013/14[a]	24.8	27.6	3.6	3.9	24.1	16.8	3.2

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Table 2.29. Production of rapeseed oil by countries (million tonnes)

Years	World	EU-25/27	China	Canada	India	Japan	Other countries
2000/01	13.4	4.2	4.7	1.2	1.6	0.9	0.8
2001/02	13.1	4.4	4.3	1.0	1.7	0.9	1.0
2002/03	12.3	4.2	3.7	1.0	1.3	0.9	1.1
2003/04	14.2	4.4	4.1	1.4	1.2	0.9	2.1
2004/05	15.8	5.4	4.6	1.3	2.1	0.9	1.6
2005/06	17.5	6.0	4.6	1.4	2.3	0.9	2.3
2006/07	17.2	6.5	4.1	1.4	2.1	0.9	2.2
2007/08	18.5	7.6	3.9	1.7	2.0	0.9	2.5
2008/09	20.6	8.5	4.7	1.8	2.1	0.9	2.7
2009/10	22.6	9.4	5.2	2.0	2.2	0.9	2.9
2010/11	23.5	9.3	5.2	2.4	2.3	0.9	3.5
2011/12	24.3	9.0	5.7	3.1	2.3	1.0	3.1
2012/13	24.7	9.4	6.0	2.9	2.3	1.0	3.0
2013/14[a]	24.8	9.4	5.8	3.1	2.3	1.0	3.2

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

2.3.2. Consumption

Vegetable oils may be divided, depending on the directions of their use, into: oils for consumption, industrial use and consumption, and technical use. The group of basic oils for consumption includes: soybean oil, rapeseed oil, sunflower oil, cotton oil, peanut oil, sesame oil, olive oil, cotton oil, coconut oil, palm oil and palm kernel oil.

Because of their lathering properties palm kernel oil, palm oil and coconut oil are used in substantial quantities also for technical purposes, among others for the production of soap and detergents. In recent years, palm oil as well as rapeseed oil and soybean oil are also increasingly being used in the production of biofuels and that is why they may be classified into a separate group of industrial use and consumption oils.

The group of typical technical oils includes: castor oil, tung oil and linseed oil. They are used for the production of paints, varnishes, ink, plastic masses, enamel, surface coats, saturation of waterproof fabrics, dressing and dying of skins as well as for production of certain lubricants. Castor oil and tung oil are not fit for consumption due to their poisonous properties, while linseed oil may be (and is) used to a small extent for consumption and pharmaceutical purposes.

Table 2.30. Global use of vegetable oils (million tonnes)

Years	Total	For food purposes	For industrial purposes	including:	
				for biofuels	for other purposes industrial
2000/01	88.4	78.3	10.1	0.7	9.4
2001/02	91.2	80.3	10.9	1.0	9.9
2002/03	95.4	83.2	12.2	1.2	11.1
2003/04	101.2	87.2	14.0	1.6	12.4
2004/05	108.3	91.7	16.6	2.1	14.5
2005/06	115.1	94.8	20.4	3.6	16.7
2006/07	120.3	96.8	23.5	6.4	17.1
2007/08	126.7	100.1	26.6	10.2	16.4
2008/09	131.6	103.5	28.1	15.1	13.0
2009/10	139.7	108.2	31.5	17.0	14.5
2010/11	146.3	111.8	34.6	18.3	16.3
2011/12	152.5	115.7	36.8	21.7	15.1
2012/13	157.4	120.2	37.2	21.8	15.4
2013/14[a]	163.2	124.2	39.0	20.9	18.1

[a] Estimate.

Source: prepared by the author on the basis of data from USDA and the author's estimates.

The global use of oils is characterized by a long-term increasing trend. The use of vegetable oils for food purposes in developing countries, characterized by high demographic indexes, is dynamically growing. These countries include: China, Brazil, Indonesia or Malaysia, while their use in the production of biofuels increases mainly in developed countries. The use of vegetable oils in the food sector in developed countries is growing slowly due to the high market saturation with these products as well as stagnation or the decrease in the number of people.

The global use of vegetable oils in 2000/01-2012/13 increased by 78% (from 88 million tonnes to 157 million tonnes), while the use of oils for industrial purposes was growing much faster than for food purposes. The use for food purposes increased by 53% (from 78 million tonnes to 120 million tonnes), and the use for industrial purposes grew almost four times (from 10 million tonnes to 37 million tonnes). The use in the biofuel sector grew more than thirty times (from 0.7 million tonnes to 22 million tonnes). The available data demonstrates the fact that the use of palm oil for industrial purposes increased four times (to 14 million tonnes in the season 2012/13), while the use of rapeseed oil – six times (to more than 7 million tonnes).

As a result of these changes, the share of oils used for industrial purposes in the total use of vegetable oils increased from 11% in the season 2000/01 to 24% in the season 2012/13, and the share of oils used for food purposes decreased accordingly from 89% to 76%. In the case of palm oil, the share of its use for industrial purposes increased from 15% to 26%, and in the case of rapeseed oil – from 9% to 31%.

Table 2.31. Use of vegetable oils in selected countries and regions (million tonnes)

Years	EU-25/27		China		India		South-East Asia		Middle East	
	A	B	A	B	A	B	A	B	A	B
2002/03	12.1	2.5	16.4	1.0	10.1	0.6	6.0	3.8	6.0	3.8
2003/04	12.3	3.3	17.4	1.5	10.7	0.5	6.4	4.2	6.4	4.2
2004/05	12.9	4.6	18.7	1.9	11.0	0.6	6.8	4.7	6.8	4.7
2005/06	13.0	6.7	19.4	2.2	11.4	0.7	7.3	5.5	7.3	5.5
2006/07	13.0	8.4	20.2	2.3	11.1	0.8	7.3	5.5	7.3	5.5
2007/08	12.8	9.1	21.0	2.4	12.1	0.9	7.4	6.1	7.4	6.1
2008/09	13.2	9.6	22.2	2.5	13.7	0.9	7.5	6.8	7.5	6.8
2009/10	12.9	11.1	24.4	2.5	14.6	0.6	8.5	7.3	8.5	7.3
2010/11	12.6	11.2	25.2	2.5	15.4	0.6	9.0	8.7	9.0	8.7
2011/12	12.6	11.0	26.6	2.6	16.3	0.8	9.6	9.2	9.6	9.2
2012/13	12.5	10.8	28.3	2.8	17.5	0.7	9.9	10.3	9.9	10.3
2013/14[a]	12.6	10.9	29.8	2.9	18.5	0.7	10.5	10.8	10.5	10.8

A – for food purposes, B – for industrial purposes.
[a] Estimate.
Source: prepared by the author on the basis of data from USDA.

The use of vegetable oils increased to the largest extent in 2000/01--2012/13 in China, Brazil, Indonesia and Malaysia – 2.5 times, it increased by 67% in the EU and only by 32% in the USA. The largest consumer of oils is China (20% of share in the season 2012/13) which has recently taken the second place in their global production (it occupied the third place until the season 2010/11). It is followed by the EU-27 (15%), India (12%) and the USA (8%) which occupy, accordingly, the fourth, eighth and fifth place in the global production of oils.

The growth rate of the use of vegetable oils in the food sector is the highest in developing countries. It amounted to 6% annually on average in China and India in 2002/03-2012/13. Developed countries record low increases in the use of oils in the food sector (0.3% in the EU on average in 2002/03--2012/13), but high increases in the industrial sector (16% in the EU on average in 2002/03-2012/13). When the current growth factor in the use of oils is the production of biodiesel, developed countries lead in the use of oils per capita.

The development of the biofuel sector in the next years will be the main driver of global demand for vegetable oils. The biofuel sector is estimated to have actively involved as much as 40-50% of the growth in the global production of oils throughout the last few years.

2.3.3. Trade

The international trade in vegetable fats is conducted both in the form of oilseeds and in the form of vegetable oils. Imported seeds are processed into oil and fodder meal, while the meal may be re-exported depending on the needs of the internal market.

The dynamically growing demand for vegetable fats from the food sector, especially industrial, resulted in a very significant growth in the international turnover of oilseeds and vegetable oils in the last decade, while the geographic directions of trade in these products have not changed substantially. Europe as well as Asian countries (mainly, China and India) still were deficit in these raw materials and thus their largest importers, while North American countries (the USA, Canada) and South American countries (Brazil, Argentina) as well as South-East Asian countries (Malaysia and Indonesia) remained surplus regions and key exporters.

The dynamics of the international turnover of oilseeds, particularly vegetable oils, in 2000/01-2012/13 was higher than the dynamics of their production. The global export of oilseeds increased at that time by 72% (from 67 million tonnes to 115 million tonnes) and their production by 50%, while the global export of vegetable oils increased by 115% (from 31 million tonnes to 61 million tonnes) and their production by 78%.

Table 2.32. Export of oilseeds by countries (million tonnes)

Years	World	USA	Brazil	Argentina	Canada	Paraguay	Ukraine	Other countries
2000/01	66.9	28.0	15.5	6.5	6.1	2.6	1.1	7.2
2001/02	62.4	30.0	15.0	7.5	3.7	2.2	0.1	3.8
2002/03	70.0	29.4	19.8	9.2	3.3	2.8	0.4	5.2
2003/04	66.8	25.2	20.6	7.0	4.8	2.8	1.0	5.4
2004/05	74.4	30.7	20.2	10.1	4.7	2.9	0.1	5.6
2005/06	75.8	26.6	26.0	7.8	6.8	2.4	0.6	5.5
2006/07	83.1	31.7	23.5	10.2	7.3	3.9	1.2	5.2
2007/08	91.3	33.1	25.4	14.4	7.7	4.7	1.2	4.9
2008/09	94.6	35.7	30.1	6.3	10.0	2.3	3.7	6.5
2009/10	106.9	41.7	28.7	13.8	9.5	4.1	2.4	6.8
2010/11	108.3	41.9	30.1	10.0	10.2	5.3	2.9	8.0
2011/12	111.5	37.8	36.5	8.1	11.7	3.6	2.8	11.0
2012/13	115.0	36.8	41.1	7.3	10.7	5.6	3.0	10.7
2013/14[a]	125.8	38.0	42.6	13.6	11.0	5.6	4.3	10.7

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Table 2.33. Import of oilseeds by countries (million tonnes)

Years	World	China	EU--25/27	Japan	Mexico	Taiwan	Thai-land	Other countries
2000/01	65.6	13.3	17.5	4.8	4.4	2.3	1.3	22.1
2001/02	63.6	10.4	18.5	5.0	4.5	2.6	1.6	21.0
2002/03	71.0	21.5	18.8	7.5	5.3	2.4	1.8	13.7
2003/04	64.2	17.4	16.9	7.3	5.3	2.2	1.5	13.6
2004/05	72.7	26.1	16.0	6.8	5.1	2.3	1.6	14.8
2005/06	75.4	29.0	15.9	6.6	5.5	2.5	1.5	14.4
2006/07	80.7	29.7	17.2	6.6	5.4	2.4	1.6	17.9
2007/08	90.1	38.6	17.0	6.5	5.3	2.2	1.8	18.6
2008/09	93.9	44.1	18.0	5.7	4.7	2.2	1.6	17.5
2009/10	101.8	52.5	15.9	5.9	5.2	2.5	1.7	18.0
2010/11	103.8	53.7	16.3	5.5	5.4	2.5	2.2	18.3
2011/12	111.6	62.3	16.8	5.3	5.4	2.3	2.0	17.5
2012/13	111.7	63.0	16.6	5.3	5.1	2.4	2.0	17.2
2013/14[a]	121.6	71.9	16.4	5.5	5.3	2.5	2.1	18.0

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

The export of oilseeds as compared to their production increased in the analysed period from 21% to 24%, and in the case of vegetable oils – from 34% to 41%. The international trade in the season 2012/13 covered 37% of the production of soybean, 19% of the production of rapeseed as well as 75% of the production of oil palm, 21% of the production of soybean oil and 16% of the production of rapeseed oil.

Soybean remained dominant in the trade in oilseeds. Its share in the global export of seeds in 2000/01-2012/13 ranged from 81% to 88%. The share of rapeseed, which occupies the second place in the global trade in oilseeds, amounted only to 6-13%. The largest exporters of soybean included, as in the 1990s, the USA, Brazil and Argentina and its main importers – China and the EU. Canada and Australia were still the key exporters of rapeseed, and its importers – the EU, Japan, China and Mexico.

The dominant position in the trade in vegetable oils is occupied by palm oil and its share in the global export of vegetable oils in 2000/01-2012/13 increased from 54% to 63%. The share of soybean oil, which occupies the second place in the global trade of vegetable oils, decreased from 22% to 13%. The largest exporters of oil palm included, as in the 1990s, Indonesia and Malaysia, and its main importers – India, China and the EU-27. The key exporters of soybean oil, on the other hand, were still Argentina, Brazil and the USA, and its importers – China, India and the EU-27.

Table 2.34. Export of vegetable oils by countries (million tonnes)

Years	World	Indonesia	Malaysia	Argentina	Ukraine	Canada	Other countries
2000/01	30.8	6.1	10.7	4.7	0.6	0.8	7.9
2001/02	32.9	6.6	12.9	4.5	0.5	0.8	7.7
2002/03	36.0	7.4	12.6	4.6	0.9	0.6	9.9
2003/04	39.2	9.1	12.5	5.3	1.0	1.0	10.4
2004/05	42.7	11.4	13.7	6.0	0.7	1.0	9.9
2005/06	47.6	13.5	13.7	6.9	1.6	1.1	10.8
2006/07	49.1	13.4	13.8	6.9	1.9	1.3	11.9
2007/08	53.7	16.1	15.6	7.1	1.4	1.4	12.3
2008/09	55.8	18.1	16.5	5.6	2.2	1.6	11.8
2009/10	57.5	18.7	16.5	5.1	2.7	1.9	12.7
2010/11	59.7	18.5	17.7	5.6	2.7	2.5	12.8
2011/12	63.4	20.7	17.6	4.6	3.3	2.8	14.4
2012/13	66.1	22.5	18.4	4.8	3.4	2.6	14.4
2013/14[a]	68.7	23.7	18.4	5.5	4.0	2.6	14.6

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

Table 2.35. Import of vegetable oils by countries (million tonnes)

Years	World	China	India	EU- -25/27	USA	Malaysia	Pakistan	Other countries
2000/01	30.2	3.4	4.6	4.7	1.9	0.4	1.3	13.9
2001/02	30.8	3.6	4.9	5.3	1.9	0.6	1.4	13.0
2002/03	34.9	5.7	5.5	5.3	1.5	0.8	1.6	14.6
2003/04	37.7	7.1	4.6	5.6	1.9	1.2	1.3	15.9
2004/05	40.8	6.7	5.7	6.8	1.8	0.8	1.6	17.5
2005/06	44.5	7.0	4.9	8.2	2.4	1.2	1.7	19.1
2006/07	47.3	8.5	5.4	9.0	2.5	1.0	1.7	19.2
2007/08	50.7	8.8	5,9	9.0	3.1	1.3	2.0	20.5
2008/09	54.5	9.8	8.8	9.2	3.2	1.6	2.0	19.9
2009/10	56.1	9.0	9.1	9.0	3.3	2.1	2.0	21.6
2010/11	57.7	8.4	8.6	8.5	3.6	2.4	2.1	24.1
2011/12	61.6	9.2	10.0	9.0	3.8	2.7	2.3	24.6
2012/13	64.6	10.7	11.0	9.0	3.8	2.5	2.3	25.3
2013/14[a]	66.5	10.4	11.7	9.2	3.8	2.6	2.5	26.3

[a] Estimate.

Source: prepared by the author on the basis of data from USDA.

3. Global market of biofuels

3.1. Regulations on biofuel market

For many years the global markets of cereals, sugar, and recently also oilseeds and oil palm have been increasingly affected by the situation in the biofuel sector. The production of renewable energy, particularly biofuels, is growing dramatically because energy and climate problems have become the focus for the governments of numerous countries.

The costs of production of biofuels are higher than the costs of the acquisition of mineral fuels. The production cost of biofuels is greatly determined by the price of the raw material (it constitutes 55-70% of the production costs). For this reason, numerous countries introduce administrative and fiscal regulations on the biofuel market in order to popularize the use of biofuels and thus achieve the assumed social objectives regarding, e.g. environmental protection, improvement in energy security or support the development of rural areas by creating an additional source of demand for agricultural products.

The most common tool is the requirement to mix biofuels with fossil fuels to provide a guaranteed demand for biofuels. The nature of this requirement is different in different parts of the world in terms of the scope of this requirement, the period of its gradual introduction, the requested volume or the percentage share of the blend as well as the application of the national or regional strategy. The assumed share of biofuels in liquid fuels in selected countries is as follows:

USA	8.25% of biofuels in 2010
EU-27	5.75% of biofuels until 2010, 10% until 2020
Brazil	25% in gasoline in 2007, the indicator was reduced to 20% in 2010, 4% in diesel oil in 2009, 5% in 2013
Canada	5% in gasoline until 2010, 2% in diesel oil until 2012
China	10% in gasoline in five provinces
India	5% in gasoline in 2006, 5% diesel oil until 2012
Malaysia	5% in diesel oil
Indonesia	10% of biofuels until 2010

Countries also use subsidies, tax reliefs and preferential tax rates to improve the competitiveness of the production of biofuels as compared to the production of gasoline and diesel oil as well as to encourage consumers to buy them. They also introduce restrictions in the import of biofuels in order to support the forming biofuel industry.

From the end of the 1970s, the USA has used tax reliefs for the producers of bioethanol and that is why its production is increasing dynamically. Gasoline with the addition of 10% of ethanol is a commonly used fuel and statutory works are underway to increase its share up to 15%. The production of esters is also subsidized from the federal budget or it receives state tax preferences, depending on the significance of the agricultural sector in a given state.

The EU countries, with prior approval of the European Commission, may reduce taxes as compared to fuels from renewable energy sources (biofuels) in order to increase their competitiveness against fossil fuels. With prior approval of the European Commission, they may also direct public aid for the development of investments and technologies necessary for the production of biofuels. Liquid fuels blended with 5% of a biocomponent are commonly used in the EU.

Sugar plants in India interested in building systems for the production of ethanol receive state loans with reduced interest to cover 40% of the project's costs.

Brazil is promoting the use of biofuels by introducing a lower tax on selling gasoline with 25% of bioethanol which is commonly used in this country.

3.2. Production of biofuels

The global production of liquid biofuels (bioethanol and biodiesel) is growing dynamically. It increased almost six times in 2000-2012 (from 18 billion litres to 106 billion litres). The global production of biofuels, despite strong increasing trends, is still very low as compared to the global use of liquid fuels in transport. This index in the EU and in the USA is only 3-5%. It is high only in Brazil where the share of bioethanol produced from sugar cane on the market of liquid fuels is 40%.

Currently, approx. 90% of the global production of biofuels is concentrated in the USA, Brazil and the EU-27. However, the share of these countries in the global production of biofuels will decrease because this production is being developed in other countries, such as China, Malaysia or Indonesia.

The basic raw materials used for the production of liquid biofuels of the first generation are mostly cereals, sugar cane and vegetable oils. Biofuels of the first generation will be replaced in the future with biofuels of the second and subsequent generations, and non-food raw materials will be mostly used for their production. However, current technologies are very expensive and not completely perfected. For this reason, it is believed that the commercial production of biofuels of subsequent generations will be possible no sooner than in the next decade.

3.2.1. Bioethanol market

Ethyl alcohol (ethanol) is produced, above all, by distillation of products obtained during the fermentation of sugar or starch. The distillate, containing 95.57% of alcohol and 4.43% of water, is known as the rectification product. Absolute (anhydrous) alcohol is the result of dehydration of the rectification product. The term bioethanol applies to alcohol fuel obtained from organic renewable sources.

Ethanol, including for energy purposes, may be obtained from any raw material containing sugars or starch, e.g. sugar cane, cereals (mostly maize, wheat), sugar beet or potatoes. Cellulose biomass, e.g. grass, waste from wood processing, organic waste (the so-called raw materials of the second generation) may also be used for the production of ethanol. However, so far the production of ethanol from these raw materials is very expensive. Ethyl alcohol may also be obtained synthetically by hydration of ethylene or by hydrogenation of acetaldehyde.

Bioethanol in spark-ignition engines (gasoline engines) may be used as fuel as follows:

- on its own as 95% ethanol containing minute quantities of water, a substitute of gasoline and may be used in engines adapted for its combustion, not suitable for blends with other fuels due to the small quantities of water,
- as anhydrous (99%) ethanol – it may be used as an addition to traditional fuels (gasoline) in proportions from 5% (E5) to 85% (E 85); an addition amounting to 5% (E5) may be used in contemporary combustion engines without any additional modifications, the higher content of bioethanol requires changes in engines,
- in the form of ethyl tert-butyl ether (ETBE) as an addition to gasoline.

Bioethanol may also be used as an addition to diesel oil but this solution is of minor significance due to additional modifications to the structure of engines.

Despite the fact that the production technology of bioethanol from cereals or other raw materials is very well developed, the differences in production costs result from differences in prices of raw materials and their efficiency, the quantity of consumed energy (both thermal energy and electricity) and the prices of obtained by-products. The costs of raw materials are a dominating item in the structure of production costs of biofuels, including bioethanol. In the USA, they were at the level of approx. 30% under 2004 price conditions as regards the production of ethanol from maize[8]. Another significant component of the production costs of biofuels is energy which constitutes up to 20-25% of total costs.

Due to the fact that the prices of raw materials are a dominating item in the structure of production costs, the access to cheap agricultural products is of key importance in the profitability of the production of biofuels. That is why much depends on solutions applied in the agricultural policy in this respect.

New trends in the prices of raw materials for the production of bioethanol have become visible in recent years. The prices of cereals increased significantly and that is why today the share of raw materials in total production costs of biofuels obtained from cereals ranges from 70-80%. The production costs of biofuels expressed in USD per litre were lower than the production costs of fossil fuels only in Brazil (USD 0.22 per litre of bioethanol or USD 0.33 per litre of an energy equivalent of gasoline). The production costs of ethanol in this country were lower than the price of traditional gasoline excluding taxes, and lower than the Regional Delivery Costs[9] (*Polish: Regionalny Koszt Dostawy*). In 2004, the production costs of ethanol, produced in other countries from wheat and sugar beet, exceeded the prices of gasoline (net without imposed taxes) by 30-40%, and much more in recent years.

The ratio of oil prices to the prices of raw materials from which biofuels are produced is the main index of their competitiveness. This proportion in the case of cereals was shaped for the benefit of maize after 2004 (growing oil prices and the stabilization of cereals prices), but these relations deteriorated from the second half of 2006. The increases in the prices of cereals in recent years only made this disproportion deeper. However, the production of biofuels supported with various mechanisms is growing systematically, only the dynamics of this process decreased. So far the most important raw materials for the production of bioethanol are sugar cane and maize. The first raw material is used in large quantities in Brazil, and the second one – in the USA, namely by the main producers of bioethanol in the world. Tradition and the habit of cultivation of the plants referred to above play a major role here. Bioethanol in Europe is produced mostly from cereals and sugar beet, and its main producers include Germany, France, Spain and Sweden.

The production of bioethanol has been dynamically growing in recent years and significantly exceeded 110 billion litres (2012). As compared to 2003,

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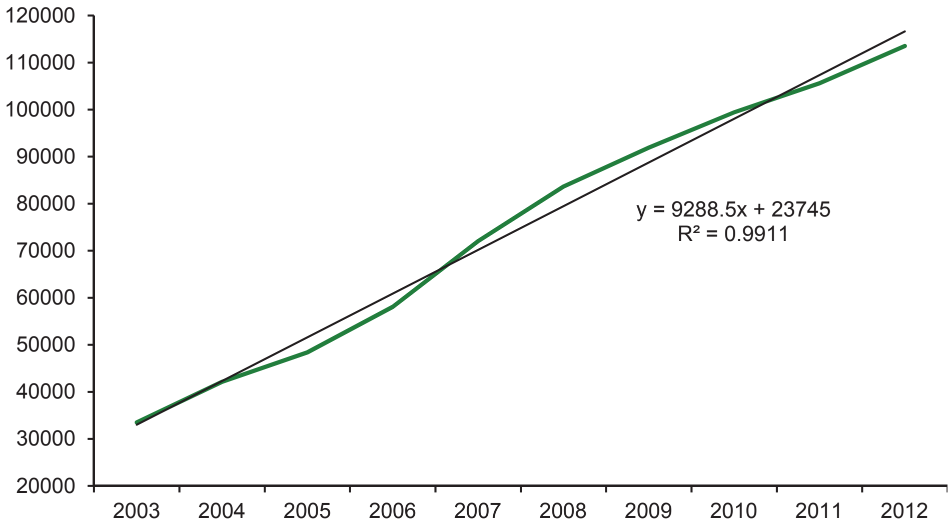
[8] *Agricultural market impacts of future growth in the production of biofuels*, OECD, 1.02.2006.

[9] The RKD of gasoline or diesel oil includes the price of crude oil, the costs of refining and distribution in a given region of the globe.

its volume was more than 3 times higher. The annual growth rate in production within this period amounted to more than 9 billion litres.

Figure 3.1. Production of bioethanol in the world (million litres)



Developed countries dominate in the production of bioethanol. In 2012, their share accounted for 48% as compared to 41% in 2003. The figures demonstrate the fact that this group of countries was developing the production of the above-mentioned raw material. The production of bioethanol in developed countries in 2012 was 3.5 times higher than in 2003. The highest growth was recorded in Canada and in the USA. At that time, developing countries increased their production more than twice, mainly due to Brazil.

The production of bioethanol within the next 10 years may increase by 67%. The demand of this sector in 2022 will amount to nearly 12% of the total use of cereals.

Table 3.1. Production of bioethanol in the world by groups of countries and major producers (million litres)

Specification	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2012/2003 %
Developed countries	**13610**	**2929**	**18896**	**24773**	**33952**	**41683**	**52126**	**57532**	**58091**	**54454**	**345**
including:											
USA	11045	12596	15332	20153	28714	35621	44580	49044	49410	45265	364
EU	1969	2338	2762	3444	3923	4340	5608	6290	6530	6842	255
Canada	380	382	439	761	859	1240	1349	1527	1497	1692	366
Developing countries	**20760**	**21048**	**21449**	**24562**	**29880**	**35560**	**33942**	**37964**	**41750**	**45200**	**227**
including:											
Brazil	12140	13544	15712	17921	22328	27853	25724	27571	24923	23624	220
China	5893	6273	6651	6846	6941	7000	7317	8378	8600	8950	135
World	**33514**	**42148**	**48398**	**58084**	**72059**	**83640**	**91909**	**99423**	**105608**	**113537**	**235**

Source: OECD.

3.2.2. Biodiesel market

Biodiesel is a biofuel of the first generation obtained from food raw materials during the esterification of fatty acids contained in animal or vegetable fats. Both the esters of fatty acids, and blends of esters with diesel oil in certain proportions, which are used in diesel engines, are called biodiesel.

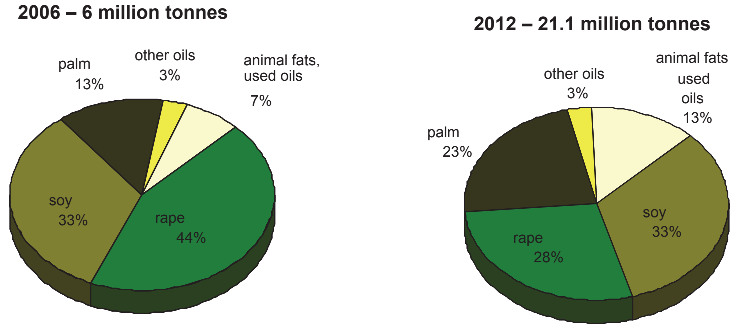
Currently, biofuels of the first generation used in diesel engines are produced mainly on the basis of soybean oil, rapeseed oil and palm oil, while their use in this production is diverse in individual regions of the world. Rapeseed oil is mostly used for the production of biofuels in North and Central Europe where the cultivation of rapeseed is dominant. The share of soybean oil is increasing in the production of biofuels in the southern part of the European continent (Italy, Spain and Portugal). The main raw material used in the production of biofuels in the United States and in South American countries (Brazil, Argentina, Paraguay) is soybean oil because the cultivation of soybean is dominating there. The production of biofuels in South-East Asian countries (Malaysia, Indonesia) is conducted mostly on the basis of palm oil produced there on a large scale.

Rapeseed oil had the largest significance in the global production of biodiesel until 2010, but its share in this production was systematically decreasing, while the share of soybean oil and palm oil was growing. From 2011, the largest share in the global use of raw materials for the production of biodiesel is attributed to soybean oil (33% in 2012), and then rapeseed oil (28%), and palm oil (23%). The share of other oils (sunflower oil, coconut oil and other oils) amounts to 3%, and the remaining raw materials – 13% (these are mainly vegetable oils and animal fats).

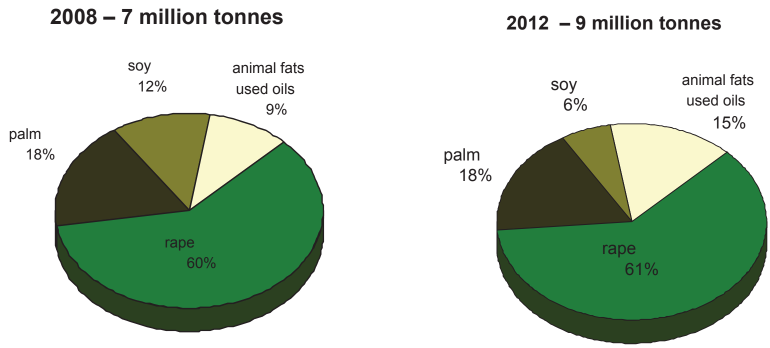
It should be emphasized that a number of countries in the world prepared development programmes for the production of biodiesel planning various sources of raw materials for such production, while these are mainly vegetable oils from domestic raw materials and less frequently animal fats or used frying oils. Less significant raw materials used in the production of biodiesel include, e.g. oil obtained from the jatropha plant which will play an increasingly important role in its production, in particular in African countries because this plant may be cultivated only in subtropical regions.

Figure 3.2. Structure of use of raw materials for the production of biodiesel[a]

The world



The European Union

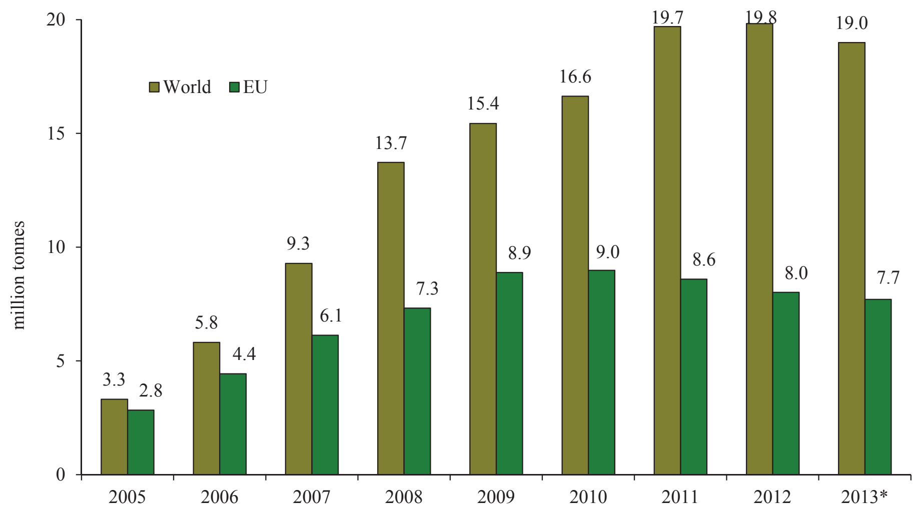


[a] Applies to 2012, FAME and HVO.
Source: prepared by the author on the basis of data from F.O. Licht.

In the 90s the global production of biodiesel was small, it did not exceed 0.5 million tonnes. It developed dynamically no sooner than in the 2000s, as a result of the implementation of development programmes for the production of biofuels by numerous countries. The production of biodiesel fuel increased from approx. 1 million tonnes at the beginning of the 2000s to more than 3 million tonnes in the middle of the 2000s, and to almost 20 million tonnes in 2011-2012. A significant slowdown in the development of the global production of biodiesel took place in 2012, and forecasts for 2013 even assume its reduction to approx. 19 million tonnes due to the continuing slowdown of the global economy and a significant decrease in the profitability of this production. The global production of biodiesel in 2012 was slightly higher than in the past year.

Its increase amounted to less than 1% as compared to 18% growth in 2011, 8% in 2010 and 12% in 2009.

Figure 3.3. Production of biodiesel (million tonnes)



* Estimate.

Source: prepared by the author on the basis of data from F.O.

Table 3.2. Global balance of biodiesel (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
Production	3315	5817	9289	13724	15438	16636	19697	19829	18994
Import	58	356	1343	3737	2583	2596	3343	3677	1987
Consumption	3155	5250	8984	12290	14993	17218	19652	19156	19924
Export	90	253	1431	3832	2712	2603	3494	3599	2055
Stocks	466	1136	1353	2692	3008	2419	2313	3064	2066

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

Table 3.3. Balance of biodiesel in the EU (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
Production	2838	4434	6129	7321	8888	8981	8595	8013	7708
Import	0	91	820	2533	1947	2092	2645	2776	1000
Consumption	2742	4076	7055	9052	10688	11560	11367	10212	8939
Export	50	15	21	60	66	103	88	83	50
Stocks	346	780	653	1395	1476	886	671	1165	884

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

The EU is the largest producer and consumer of biodiesel on the global scale. The development of this production in the EU is fostered by the structure of use of liquid fuels. The advantage of diesel oil use over the use of gasoline has been increasing in the EU countries from 1997. The number of vehicles and machines with diesel engines (powered by diesel oil) is still growing and the number of vehicles with spark-ignition engines (powered by gasoline) is decreasing. The use of diesel oil in the EU countries in 2008 (160 million tonnes – 24% of the global production) was larger by 50 million tonnes than the use of gasoline and this difference is constantly increasing.

Table 3.4. Production of biodiesel by regions

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
Production in thousand tonnes									
World	**3315**	**5817**	**9289**	**13724**	**15438**	**16636**	**19697**	**19829**	**18994**
Europa	2838	4464	6181	7415	8991	9129	8720	8187	7886
South America	21	163	670	1882	2815	4151	5105	5233	4720
North and Central America	315	885	1783	2784	1804	1238	3303	3299	3751
Asia	117	280	625	1591	1725	1986	2428	2973	2500
Oceania	20	25	30	52	102	132	142	137	137
Structure in %									
World	100	100	100	100	100	100	100	100	100
Europa	86	77	67	54	58	55	44	41	42
South America	1	3	7	14	18	25	26	26	25
North and Central America	10	15	19	20	12	7	17	17	20
Asia	4	5	7	12	11	12	12	15	13
Oceania	1	0	0	0	1	1	1	1	1
Dynamics in %									
World	100	175	280	414	466	502	594	598	573
Europa	100	157	218	261	317	322	307	288	278
South America	100	776	3190	8962	13405	19767	24310	24919	22476
North and Central America	100	281	566	884	573	393	1049	1047	1191
Asia	100	239	534	1360	1474	1697	2075	2541	2137
Oceania	100	125	150	260	510	660	710	685	685

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

The production of biodiesel in the EU increased from approx. 1 million tonnes in 2000-2001 to approx. 3 million tonnes in 2005, and approx. 9 million tonnes in 2009-2010. However, the previous systematic growth in the production of biodiesel in the EU was stopped at the beginning of the current decade. It decreased to 8.6 million tonnes in 2011 and 8 million tonnes in 2012, despite the fact that the biodiesel sector increased its production capacities (from 10 million tonnes in 2007 to 16 million tonnes in 2008, 21 million tonnes in 2009, 22 million tonnes in 2010--2011, and 23.5 million tonnes in 2012). The decrease in production in the last two years was determined by the cheap import of biodiesel, initially from the USA and then from Argentina and Indonesia, as well as a decrease in the demand for biofuels, due to the continuing economic crisis and a change in the EU policy towards biofuels. In 2013, a further decrease in the production of biodiesel in the EU is forecasted to the level of 7.7 million tonnes.

Table 3.5. Production of biodiesel by countries (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
World	**3315**	**5817**	**9289**	**13724**	**15438**	**16636**	**19697**	**19829**	**18994**
EU	2838	4434	6129	7321	8888	8981	8595	8013	7708
USA	300	825	1701	2694	1703	1132	3191	3198	3650
Brazil	1	60	356	1027	1415	2100	2352	2391	2550
Argentina	20	100	300	712	1179	1815	2427	2455	1700
Indonesia	10	50	245	600	500	800	1250	1350	1150
Thailand	21	45	60	394	493	524	556	789	500
Columbia	0	0	8	130	190	200	250	260	270
South Korea	10	20	40	80	170	240	240	240	240
Malaysia	15	50	100	190	240	117	60	240	240
Australia	20	25	30	50	100	130	140	135	135
China	40	60	100	135	140	140	140	140	140
Philippines	10	20	30	50	95	105	107	114	120
Canada	15	60	82	90	100	105	108	100	100
Taiwan	0	0	0	5	32	20	50	75	75
Peru	0	0	0	0	10	10	20	30	40
Singapore	1	15	40	115	40	15	15	10	20
India	10	20	10	22	15	25	10	15	15
Other countries	4	33	58	109	128	177	186	274	341

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

The main raw material for the production of biodiesel in the EU is rapeseed oil (61% in the total use of raw materials in 2012). Its use in this production increased six times over twelve years (from 1.1 million tonnes in the season 2001/02 to 5.4 million tonnes in 2012). Taking into account the dynamically growing use of rapeseed oil in the production of biofuels, its use for food purposes in the EU-27 was slowly decreasing (from 2.9 million tonnes in the season 2001/02 to 2.6 million tonnes in the season 2005/06), and then it grew slightly (to 3.3 million tonnes in the season 2009/10). As a result of these changes, from the season 2005/06 the use of rapeseed oil in the production of biofuels in the EU-27 is higher than in the food sector and this advantage is currently double.

The largest producer of biodiesel in Europe is Germany (2.5 million tonnes on average in 2010-2012, 29% of share in the EU production). Subsequent places in this production are occupied by: France (1.7 million tonnes, 20% of share), Spain (0.6 million tonnes, 8% of share), Italy (0.6 million tonnes, 7% of share), Poland (0.4 million tonnes, 5% of share) and the Netherlands (0.4 million tonnes, 5% of share).

Despite the fact that the EU still is the leader in the global production of biodiesel, its share in this production decreased from more than 85% in 2005 to 40% in 2012. The production of biodiesel in other countries, including Argentina, Brazil, the USA and Asian countries, is developing extremely dynamically. The countries referred to above develop their production of biodiesel not only for own needs but also to develop export.

Table 3.6. Production of biodiesel in the EU-27 by countries (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
EU	**2838**	**4434**	**6129**	**7321**	**8888**	**8981**	**8595**	**8013**	**7708**
Germany	1450	2200	2890	2600	2500	2350	2780	2400	2100
France	429	592	954	1763	2089	1996	1400	1650	1750
Poland	64	89	44	170	396	371	364	592	510
Netherlands	0	18	85	83	274	382	491	400	500
Italy	396	594	470	668	798	799	620	350	400
Belgium	1	1	145	277	416	350	350	330	330
Portugal	0	79	181	169	255	318	366	313	313
Austria	70	122	242	250	323	337	310	310	310
Great Britain	9	256	427	282	196	154	177	270	290
Spain	162	125	180	221	727	841	649	440	250
Czech Republic	127	110	82	75	155	198	210	160	150
Sweden	8	48	114	145	110	130	130	130	130
Slovakia	35	43	46	105	103	113	125	110	100
Denmark	70	70	70	98	86	76	80	70	70
Slovenia	6	2	7	8	7	21	0	6	6
Other countries	11	85	192	407	453	545	543	482	499

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht .

The export of biodiesel increased on the global scale from 90 thousand tonnes in 2005 to 3.8 million tonnes in 2008, and then decreased to 2.6-2.7 million tonnes in 2009-2010, while it increased again to 3.5-3.6 million tonnes in 2011-2012. It accounted for 3% in 2005, 28% in 2008 and 16-18% in 2009-2012 as compared to production. The largest exporters of biodiesel include Argentina (43% of share in 2012), Indonesia (34%) and the USA (11%), and the EU is its key importer (75% of share in 2012). The dependence of the EU on the import of biodiesel or vegetable oils for its production will increase. The EU has limited possibilities of development of oilseeds cultivations and the demand of the European sector of biofuels for vegetable oils will be systematically increasing until the end of the decade, following the growing use of diesel oil and the growing share of biocomponents in liquid fuels. It is expected that the EU will have to import 25% of necessary biofuels or oils for their production to achieve the assumed 10% share of biofuels in the use of liquid fuels in 2020.

However, the production of biodiesel in the EU should increase in subsequent years due to the growing mandatory ratio of share of biofuels in liquid fuels (to 10% in 2020).

Table 3.7. Use of biodiesel by countries (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
World	**3155**	**5250**	**8984**	**12290**	**14933**	**17218**	**19652**	**19156**	**19924**
EU-27	2742	4076	7055	9052	10688	11560	11367	10212	8939
USA	300	861	1181	1040	1076	868	2904	3054	4500
Brazil	0	40	228	990	1377	2167	2300	2460	2550
Argentina	0	0	0	0	1	508	751	875	900
Thailand	4	5	30	407	535	554	507	529	650
Indonesia	0	10	39	40	105	196	316	350	500
Peru	0	0	0	0	80	86	239	251	260
Malaysia	0	0	0	0	6	6	15	110	224
Australia	15	20	25	56	106	150	150	150	150
Canada	10	40	85	85	50	60	100	100	100
India	0	20	20	10	10	10	10	10	10
Other countries	84	178	321	610	899	1053	993	1055	1141

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

Table 3.8. Export of biodiesel by countries (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
World	**90**	**253**	**1431**	**3832**	**2712**	**2603**	**3494**	**3599**	**2055**
Argentina	10	20	164	689	1150	1366	1692	1558	800
Indonesia	0	29	213	420	190	545	1100	1220	600
USA	29	90	862	2256	806	287	254	413	100
Canada	0	9	19	71	200	110	100	75	150
Malaysia	0	48	95	182	228	90	50	29	100
EU-27	50	15	21	60	66	103	88	83	50
Singapore	1	12	26	103	32	13	2	18	20
Brazil	0	0	0	0	2	7	5	11	15
India	0	0	0	10	25	37	38	5	5
Thailand	0	0	0	0	1	1	0	0	0
Other countries	0	30	31	41	12	44	165	187	215

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

Table 3.9. Import of biodiesel by countries (thousand tonnes)

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
World	**58**	**356**	**1343**	**3737**	**2583**	**2595**	**3343**	**3677**	**1987**
EU-27	0	91	820	2533	1947	2092	2645	2776	1000
USA	29	191	407	1049	259	79	125	116	400
Peru	0	0	0	0	80	75	220	220	220
Canada	0	33	40	3	115	60	30	242	50
Australia	0	0	0	9	1	31	6	23	20
Brazil	0	0	0	0	4	8	15	12	15
India	0	0	0	0	20	24	46	2	1
Malaysia	0	0	0	0	0	0	8	0	0
Singapore	0	0	0	0	0	1	3	1	0
Thailand	0	0	0	0	0	0	1	0	0
Other countries	29	41	76	143	157	225	244	285	281

[a] Estimate.

Source: prepared by the author on the basis of data from F.O. Licht.

4. Impact of production of biofuels on cereal market

An attempt was made to assess the impact of the biofuel sector on the cereals market on the basis of the analysis of the basic elements of this market with breakdown into wheat and cereals for fodder. The analysis of relation between production and use in the global balance demonstrates a decrease in the surpluses of cereals in the past and in the current decade, particularly on the market of cereals for fodder, where the growth in use exceeded the growth in production in the analysed period to a greater extent than on the wheat market.

From the geographic perspective, the volumes of surpluses on the wheat market decreased in almost all regions of the world, both exporter and deficit regions in the production of wheat. Exceptions include the CIS countries where the level of surpluses increased several times as well as South America and East Asia where no greater changes were recorded. Despite the production growth in developing countries, most of them experienced an increase in shortages which is caused by the growing demand for consumption purposes.

The situation on the market of cereals for fodder is slightly different. The increase in the demand for cereals in developed countries results also from the growth in industrial use, including in the biofuel sector. This situation particularly applies to the leader in this field – the USA, where almost 40% of maize is currently used for the production of bioethanol.

A significant growth in surpluses in South America, the CIS and Oceania did not compensate the deepening decrease, above all, in exporter countries of the EU, North America as well as in deficit regions (East Asia, Africa, the Middle East). This demonstrates the fact that the determining role in the reduction in surpluses of cereals for fodder is played by the growing demand in developed countries where consumption and industrial use grow to a greater extent and the increasing pasturing in developing countries.

The direct consequence of declining surpluses is the reduction in the level of stocks of cereals which constitute a protection in the event of a decreasing supply (harvest). This, in turn, affects shifts in the structure of supply where the share of current supply is growing at the expense of collected stocks, particularly in years of poor harvest. This mechanism leads to a greater instability on the market of cereals because stocks are a protection (reserve) in the case of unexpected changes on the market and are becoming smaller and smaller.

Figure 4.1. Surpluses/shortages on global market of cereals (million tonnes)

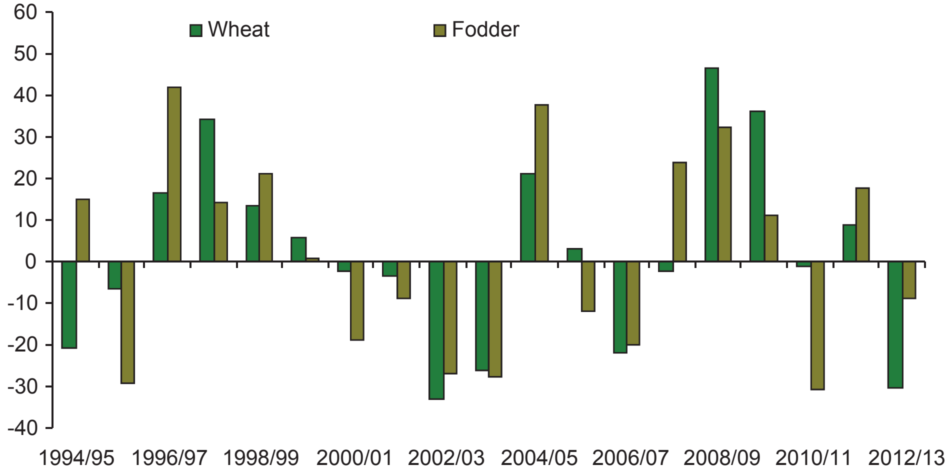
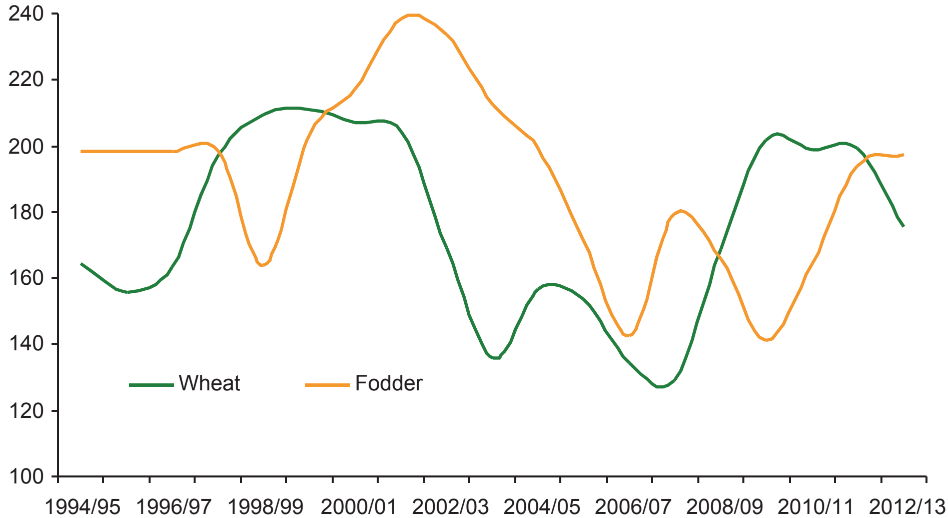


Table 4.1. Surpluses/shortages in balance of cereals (million tonnes)

Specification	1994/95--1999/00	2000/01--2005/06	2006/07--2012/13	Differences		
	[1]	[2]	[3]	[2]-[1]	[3]-[2]	[3]-[1]
Wheat						
EU	13.545	8.412	11.234	-5.1	2.8	-2.3
East Asia	-9.250	-23.107	-8.874	-13.9	14.2	0.4
South-East Asia	-8.345	-10.351	-13.527	-2.0	-3.2	-5.2
CIS	-5.341	11.509	21.597	16.9	10.1	26.9
North America	45.173	35.938	40.485	-9.2	4.5	-4.7
Middle East	-11.161	-9.706	-15.551	1.5	-5.8	-4.4
Oceania	14.443	15.179	13.828	0.7	-1.4	-0.6
South America	-2.198	-1.305	-2.035	0.9	-0.7	0.2
Africa	-21.158	-26.991	-35.245	-5.8	-8.3	-14.1
Other	15.707	-0.422	11.912	-16.1	12.3	-3.8
World in total	**7.061**	**-6.791**	**4.897**	**-13.9**	**11.7**	**-2.2**
Cereals for fodder						
North America	52.206	43.019	32.520	-9.2	-10.5	-19.7
East Asia	-27.277	-42.460	-30.833	-15.2	11.6	-3.6
EU	4.374	1.613	-4.943	-2.8	-6.6	-9.3
South America	3.581	10.035	25.561	6.5	15.5	22.0
Africa	-6.723	-10.856	-11.415	-4.1	-0.6	-4.7
CIS	-0.227	5.807	13.362	6.0	7.6	13.6
South-East Asia	-3.593	-3.369	-4.877	0.2	-1.5	-1.3
Middle East	-12.190	-15.130	-20.492	-2.9	-5.4	-8.3
Oceania	3.507	5.267	4.403	1.8	-0.9	0.9
Other	13.659	-6.073	3.286	-19.7	9.4	-10.4
World in total	**10.733**	**-9.559**	**2.337**	**-20.3**	**11.9**	**-8.4**

Source: own calculations on the basis of data from USDA.

Figure 4.2. Global stocks of cereals (million tonnes)



Data relating to the balance of cereals coming from the US Department of Agriculture (USDA) does not specify the quantity of cereals intended for industrial use, including cereals for fodder. Data from the International Grain Council (IGC) was used to analyse the relations between particular components of use. The time frames of data, however, are determined by the availability of data on industrial use and use in the biofuel sector as well as by the size of the latter.

The industrial use of wheat in the global scale in the season 2012/13, as compared to the season 2005/06, increased by 77%, namely to a much greater degree than the remaining components of demand. Its share increased by almost 1 percentage point to approx. 3%. The significance of industrial use on the market of cereals for fodder, including processing into biofuels, is much greater than on the wheat market. The demand for grain for processing into bioethanol grew even faster in this segment (increase by 57%), but it amounts to 1% of the global use so far.

The use of cereals for fodder for industrial purposes grew twice from the season 2004/05 to the season 2011/12 to approx. 282 million tonnes and their share in the use of cereals for fodder in total increased by 11 percentage points to 24%. Approximately half of this volume was used for the production of biofuels (140-150 million tonnes within a year) – mostly maize. The use of cereals for fodder for this purpose increased by over 50% in the seasons 2008/09--2012/13, namely much more than for other purposes. Such volume of use corresponds to the volume of stocks of cereals for fodder in recent years.

Table 4.2. Balance of wheat, structure of supply and demand (million tonnes, %)

Specification	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14 P	2012/13 / 2005/06 %
Balance (million tonnes)										
Initial stocks	126.9	137.4	137.8	121.5	120.3	168	194.1	193.1	174.9	137.8
Harvest	628.3	620.4	597.5	609.1	685.6	678.5	695.4	654.9	698.4	111.2
Import	110.2	109.9	110.8	110.3	136.7	127.7	144.8	140.8	142.3	129.1
Total supply	**755.2**	**757.8**	**735.3**	**730.6**	**805.9**	**846.5**	**889.6**	**848**	**873.3**	**115.6**
Use	**616.8**	**623.6**	**610.5**	**612.9**	**639.4**	**651.7**	**696.5**	**673.1**	**692.1**	**112.2**
Grazing	107.0	107.8	96.7	85.3	108.4	114.3	153.1	133	136.1	127.2
Consumption	436.9	439.9	441.0	445.2	446.8	452.4	460.7	465.7	471.5	107.9
Industrial use	12.9	14.3	15.0	17.0	18.3	19.0	18.8	18.4	18.9	146.5
including for bioethanol[a]	2.6	3.3	3.5	4.6	5.8	7.2	6.9	6.3	6.7	256.5
Export	110.2	109.9	110.8	110.3	136.7	127.7	144.8	140.8	142.3	129.1
Closing stocks	**137.4**	**137.8**	**121.5**	**120.3**	**168**	**198.7**	**193.1**	**174.9**	**181.2**	**131.9**
Structure of supply (%)										
Initial stocks	16.8	18.1	18.7	16.6	14.9	19.8	21.8	22.8	20.0	3.2
Harvest	83.2	81.9	81.3	83.4	85.1	80.2	78.2	77.2	80.0	-3.2
Structure of use (%)										
Grazing	17.3	17.3	15.8	13.9	17	17.5	22.0	19.8	19.7	2.4
Consumption	70.8	70.5	72.2	72.6	69.9	69.4	66.1	69.2	68.1	-2.7
Industrial use	2.1	2.3	2.5	2.8	2.9	2.9	2.7	2.7	2.7	0.6
Bioethanol	0.4	0.5	0.6	0.7	0.9	1.1	1.0	0.9	1.0	0.5

P – forecast.
[a] OECD.

Source: IGC.

Table 4.3. Balance of cereals for fodder, structure of supply and demand (million tonnes, %)

Specification	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14 P	2012/13 / 2005/06	2012/13 / 2008/09
										%	
Balance (million tonnes)											
Initial stocks	184.5	184.9	156.7	172.3	203.4	204.6	172.7	169.6	163	88.3	94.6
Harvest	985.6	990.2	1087.9	1115.9	1120.8	1099	1155.4	1135.4	1247.3	126.6	111.8
Import	105.4	110.8	129.1	112.7	112.2	116.9	124.4	124.8	134.2	127.3	119.1
Total supply	**1170.1**	**1175**	**1244.6**	**1288.3**	**1324.2**	**1303.6**	**1328.1**	**1305.1**	**1410.3**	**120.5**	**109.5**
Use	**994**	**1018.3**	**1072.2**	**1086.2**	**1117.5**	**1130.3**	**1158.4**	**1142.1**	**1212.3**	**122.0**	**111.6**
Grazing	636.2	637.1	657.3	644.8	639.5	630.8	646.7	638.3	688.8	108.3	106.8
Consumption	148.8	150.8	155.8	160.8	160.1	167.1	167.3	168.1	171.5	115.3	106.7
Industrial use	152.7	173.7	202.9	225.4	261.3	277.7	286.9	281.5	295.5	193.5	131.1
including for bioethanol[a]				103.5	128.0	130.0	140.5	130.6	156.7	-	151.4
Export	105.4	110.8	129.1	112.7	112.2	116.9	124.4	124.8	134.3	132.3	119.2
Closing stocks	**184.9**	**156.7**	**172.3**	**203.4**	**204.6**	**173.4**	**169.6**	**163.0**	**198.0**	**107.3**	**97.3**
Structure of supply (%)											
Initial stocks	15.8	15.7	12.6	13.4	15.4	15.7	13.2	13.0	11.6	-4.2	-1.8
Harvest	84.2	84.3	87.4	86.6	84.6	84.3	86.8	87.0	88.4	4.2	1.8
Structure of use (%)											
Grazing	64	62.6	61,3	59.4	57,2	55.8	56	55.9	56.8	-8.8	-2.6
Consumption	15	14.8	14.5	14.8	14.3	14.8	14.5	14.7	14.1	- 0.5	-0.7
Industrial use	15.4	17.1	18.9	20.8	23.4	24.6	24.5	24.6	24.4	10.7	3.6
Bioethanol	0.0	0.0	0.0	9.5	11.5	12.4	12.1	11.4	12.9	-	3.4

P – forecast.
[a] OECD.

Source: IGC.

The demand for raw vegetable materials in the biofuel sector is therefore the factor which has an undeniable impact on the market situation in agriculture, although its significance also depends on the market situation and the effect of other factors. The market of maize is under the direct impact of the growing production of bioethanol. Changes on markets of other vegetable products result from changes in price relations which involves the adjustment of supply and demand by an increase in product prices in most cases. The growth in vegetable product prices, in turn, increases the costs of fodder used in the sector of animal production. All these processes cause changes in the profitability of agriculture and retail prices of food.

As the use of maize for bioethanol increases, its prices grow. The higher prices of maize increase the competition between various sectors which use this grain (the spirit industry, the fodder industry), and the export demand for cereals for fodder. The growth in maize prices will result in the reduction in its share in the grazing of cereal grains. This gap is filled mostly by wheat thereby reducing its supply for other purposes (mostly for consumption). The growing prices of maize in the USA cause a decrease in this country's share in the global turnover, the growth in production and the decrease in import demand in other countries.

The growth in prices and the higher profitability of production will encourage farmers to increase the acreage of maize cultivation at the expense of soybean. They may also increase the area of maize cultivation by sowing the acreage so for under fodder or cotton cultivation. The area of maize cultivation in the USA increased in the last decade by more than 25%.

The growth in the use of maize for the production of bioethanol stimulates the growth in prices, and the reduction in demand in other segments of the market as well as the growth in supply for the market to achieve equilibrium. The closing stocks of maize will be smaller in the new equilibrium point because the market tries to achieve equilibrium through price signals based on current use and expected demand.

The demand for grain for the production of ethanol has a very low flexibility, namely it reacts to price changes poorly. The strength of this reaction is smaller than in the case of other kinds of industrial use because the biofuel sector is largely based on subsidies. It is also less flexible than the demand from the fodder industry or the export demand. Thus, as the production of bioethanol develops and the significance of this item in the balance of cereals for fodder, particularly maize, increases, the flexibility of demand will decrease. The low level of stocks and the non-flexible demand result in the fact that markets are more sensitive to any possible random events such as shortages in supply due to poor harvest, particularly if we take into account the smaller share of stocks in the supply of cereals. Similar implications occur on the markets of cereals for consumption the prices of which also grow because their increasing quantities are used for the production of bioethanol and additionally larger quantities are used for fodder. For this reason, relatively small changes in supply, in recent years, caused greater changes in cereals prices than usual. In addition, the growth in the significance of the demand for grain for the production of bioethanol in the balance of cereals connects naturally the prices of cereals with the prices of fossil fuels. In other words, it increases the dependence of cereals prices (and other agricultural products) on the situation on energy markets.

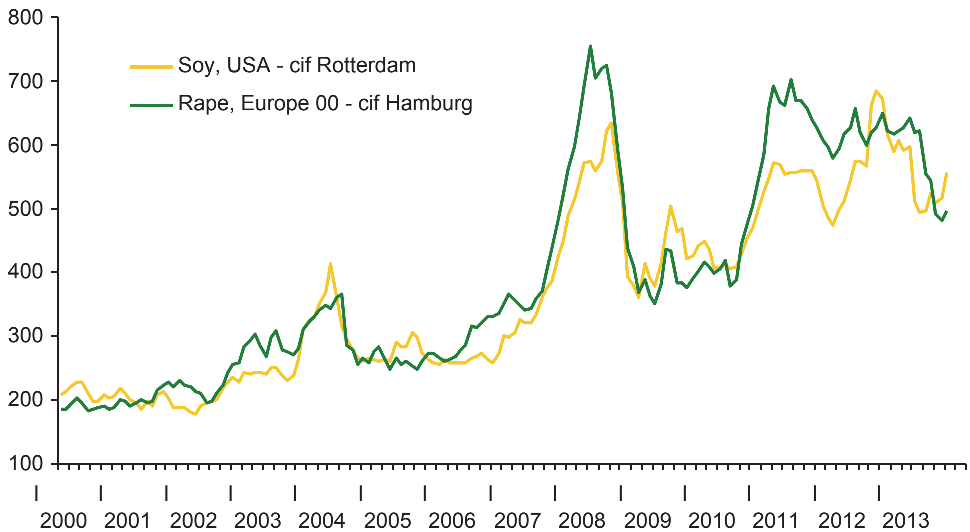
Thus, the impact of the fossil fuel market on the agricultural sector, including on the market of cereals, has intensified in recent years. The role of energy as a production asset and a factor generating production costs in agriculture has not changed. However, it currently has a substantial impact on the demand for grain and its prices. Movements in the prices of fossil fuels result in changes in the demand for grain. High crude oil prices affect the increase in the demand for ethanol and other biofuels.

The significance of bioethanol as compared to the vast liquid fuel market, including gasoline, is small, although it grows regularly at a relatively large significance on the market of cereals. It is beyond doubt that any actions aimed at supporting the biofuel sector (goal indicators, tax reliefs, limitations in trade) improve the profitability of production of cereals and will determine the development opportunities of this market.

5. Impact of production of biofuels on oilseed market

The development of the production of biodiesel which took place in the past few years was one of the major factors which caused an increase in the global production and trade in oilseeds and vegetable oils. It also contributed significantly to the growth in prices of oilseed raw materials and thus to the growth in farmers' incomes, but it also led to the growth in food prices. According to the International Food Policy Research Institute (IFPRI) from Washington, biofuels account for 30% of the growth in food prices.

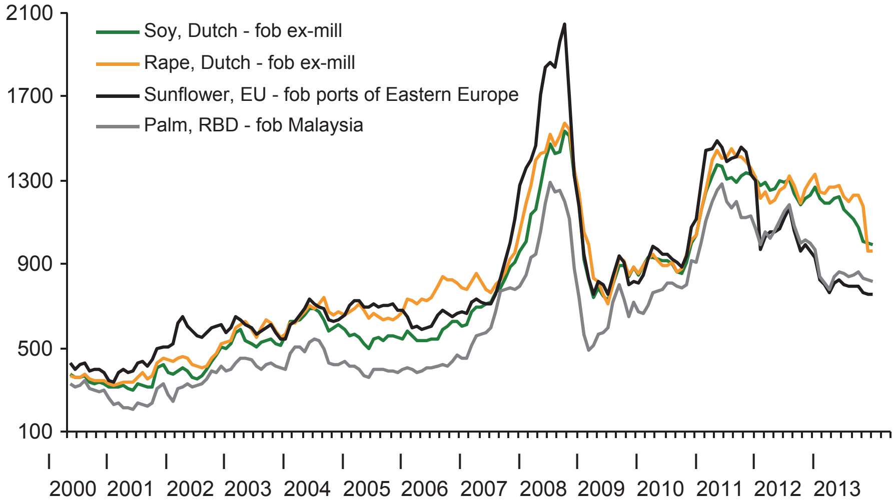
Figure 5.1. Prices of oilseeds (USD/t)
(monthly quotations)



Source: prepared by the author on the basis of data from Oil World.

The analysis of price changes over the last two decades demonstrates the fact that the prices of oilseeds were quite stable throughout the entire 1990s when the demand for oilseeds raw materials for the production of biofuels was low. The growth in prices, which took place in the middle of the 1990s, was caused by the decrease in harvest resulting from draughts in numerous regions of the world.

Figure 5.2. Prices of vegetable oils (USD/t)
(monthly quotations)



Source: prepared by the author on the basis of data from Oil World.

Table 5.1. Prices of oilseeds on global market (USD/t)

Years	Oilseeds		Oil meals		Vegetable oils			
	soybean (1)	rapeseed (2)	soybean (3)	rapeseed (4)	soybean (5)	rapeseed (6)	sunflower (7)	palm (8)
2000/01	201	193	189	139	345	318	394	239
2001/02	194	216	177	133	434	390	563	317
2002/03	239	275	186	136	574	526	602	418
2003/04	317	320	256	180	625	638	643	476
2004/05	273	263	209	131	557	663	690	400
2005/06	267	314	201	114	601	822	666	415
2006/07	361	371	270	162	833	860	916	781
2007/08	507	604	410	293	1218	1311	1573	1028
2008/09	450	448	390	210	950	997	983	691
2009/10	429	396	389	205	893	893	898	744
2010/11	524	606	410	277	1221	1278	1327	1095
2011/12	533	619	409	267	1257	1288	1269	1069
2012/13	587	614	569	372	1161	1187	1255	842
2013/14[a]	480	525	501	290	1050	1100	1110	825

(1) US, cif Rotterdam
(2) Europe, 00, cif Hamburg
(3) Soybean pellets, 45/46 Arg., cif Rotterdam
(4) 34%, fob ex-mill Hamburg
(5) Dutch oil, fob ex-mill
(6) Dutch oil, fob ex-mill
(7) EU, fob N.W. European ports
(8) RBD, fob Malaysia

[a] Estimate.

Source: prepared by the author on the basis of data from Oil World.

However, the global prices of oilseeds in the last decade were characterized by a clear upward trend despite the fact that they were subject to high fluctuations. The growth in their prices was determined mostly by the dynamically growing demand for vegetable oils from biodiesel producers. The prices of soybean and rapeseed increased from approx. USD 200 per tonne at the beginning of the previous decade to USD 360-370 per tonne in the season 2006/07 (July/June), and USD 500-600 per tonne in the season 2007/08. Vegetable oils went up even more than oilseeds, namely from USD 200-400 per tonne at the beginning of the previous decade, to USD 800-900 per tonne in the season 2006/07, and USD 1,000-1,600 per tonne in the season 2007/08. The prices of soybean and rapeseed in the season 2007/08 were over three times higher than at the beginning of the previous decade and the prices of soybean oil and rapeseed oil were four times higher.

Such a drastic growth in prices in the season 2007/08 resulted not only from the growing demand for oilseeds raw materials from the biofuel sector but was also the consequence of the decrease in the global harvest of oilseeds. It also resulted from the weakening of the dollar as compared to other currencies, it was related to a very high increase in crude oil prices and was the consequence of speculations on financial markets.

Subsequent seasons (2008/09-2009/2010), saw the weakening of the upward trends of the global and European economies due to the global financial crisis and the continuing recession. As a result, the prices of agricultural raw materials decreased and thus the prices of oilseeds and products of their processing went down. The decrease in prices was also determined by exceptionally high harvest of oilseeds in the season 2009/10.

The prices of oilseeds on global markets increased significantly again in 2010/11-2012/13, after two seasons of decreases. The demand for oilseeds raw materials used for food and biofuel on the part of their key importers, such as China, the EU or India increased further with a small growth in the production of oilseeds, including the decrease in soybean harvest in the season 2011/12. The significant increase in oilseeds prices was also determined by the repeated very large interest in agricultural raw materials on financial markets.

It is expected that the growing competition regarding agricultural raw materials, including oilseeds raw materials, between the food sector and the biofuel sector will, in the long-term, contribute to the fact that their prices will stay at high levels, although they will be subject to fluctuations because of the variability of harvest. And thus, the large growth in the harvest of oilseeds expected in the season 2013/14, both soybean which dominates in the global production of oilseeds, as well as rapeseed, sunflower and others, will contribute to the decrease in their prices, while they will still be relatively high.

Conclusions

The basic raw materials for the production of liquid biofuels of the first generation are mostly cereals, sugar cane and vegetable oils, namely agricultural products previously used primarily for food and fodder. Biofuels of the first generation thus compete with the production of food and this competition stimulates the growth in food prices and, as a result, may contribute to deepening the phenomenon of famine in the world. The comparative analysis of the global prices of agricultural raw materials and food with energy prices demonstrated the fact that the markets of food and energy show a clear integration. In 2006-2008, the production of biofuels was mentioned as one of the basic factors causing food crises and the UN, via FAO, encouraged governments to formulate a coordinated policy towards such problems as the impact of biofuels and climate change on the food market. The increasing costs of nutrition questioned the usefulness of supporting the production of biofuels. The approach to the production and use of biofuels has become more sceptical.

Numerous international analyses attributing to biofuels a smaller than previously role in the negative impact on the prices of agricultural products appeared in recent years. There are more and more opinions that food crises in the past decade were the result of an entire complex of numerous interactions between the determinants of food markets affecting the growth in food prices and people's welfare. Biofuels were only one of the elements of this set of dependencies.

The global production of liquid biofuels (bioethanol and biodiesel) in 2000-2012 increased almost six times (from 18 billion litre to 106 billion litre). According to F.O. Licht, 140 million tonnes of basic cereals (8% of their global production), 243 million tonnes of sugar cane (15% of their global production), 8.5 million tonnes of sugar beet (below 1% of its global production) and 18 million tonnes of vegetable oils (11% of its global production), among others, were used in 2012 to produce 83 billion litres of bioethanol and 20 million tonnes of biodiesel.

Despite strong upward trend, the production of biofuels is still very low as compared to the global use of liquid fuels in transport. This index in the EU and in the USA is only 3-5%. Bioethanol produced from sugar cane amounts to 40% of the use of liquid fuels only in Brazil.

Currently, approx. 90% of the global production of biofuels concentrates in the USA, Brazil and the EU-27. However, the share of these countries in the global production of biofuels will decrease because this production is being developed in other countries, such as China, Malaysia or Indonesia. Approximately

90% of the production of biofuels in the USA and Brazil is bioethanol, and biodiesel accounts for an equally large production of biofuels in the EU-27.

The costs of production of biofuels are higher than the costs of the acquisition of mineral fuels. The production cost of biofuels is greatly determined by the price of the raw material (it constitutes 55-70% of the production costs). For this reason, many countries in the world introduce administrative and fiscal regulations on the biofuel market in order to popularize the use of biofuels and thus achieve the assumed social objectives regarding, e.g. environmental protection or improvement in energy security.

The most common tool is the requirement to mix biofuels with fossil fuels to provide a guaranteed market for biofuels. The nature of this requirement is different in different parts of the world in terms of the scope of this requirement, the period of its gradual introduction, the requested volume or the percentage share of the blend as well as the application of the national or regional strategy.

The competition for agricultural raw materials between the food sector and the fuel sector and its impact on food security started a discussion on the shape of legal regulations regarding biofuels which will actually determine their future. Food security, according to FAO's definition, is the physical and economic access to food for all people, at any time, which food is safe, in terms of health, and contains the optimum quantity of nutritional components, satisfies nutritional needs and preferences enabling an active and healthy lifestyle. As part of the discussion on the shape of legal regulations regarding biofuels, the USA suggests, e.g. a reduction in the mandatory share of bioethanol in fuel and the EU has announced a partial withdrawal from the production of biofuels of the first generation. The results of these debates will, to a large extent, have consequences on the demand for raw materials for the production of biofuels in these countries as well as in the world (mainly due to the import demand for vegetable oils from the EU). They will also decide how much and which biofuels will be used in the future.

The development of the production of biofuels which took place in the last twelve years was one of the major factors that caused an increase in the global production and trade in agricultural raw materials (cereals, oilseeds and vegetable oils). It also contributed significantly to the growth in their prices and thus to the growth in farmers' incomes, but it also led to the growth in food prices and had a negative impact on food security, primarily, for people with low incomes in developing countries.

According to forecasts by FAO, the use of bioenergy, including biofuels, will increase in the future. The interest in biofuels results from the need to maintain the energy security, the climate change and the growing prices of fossil fuels. However, the assessment of the production of biofuels of the first generation comes across more and more doubts regarding the balance of energy, which should be used throughout the entire production cycle, to energy obtained (calorific value) with the use of bioethanol or biodiesel. Objections regarding their actual impact on the reduction in greenhouse gases are also being raised. Negative external effects (e.g. environmental ones), which are often omitted in the economic calculation, are also of significance. The increase in the area of sugar cane cultivation takes place at the expense of rainforests which are called *Earth's lungs*. The growing share of cereals and oilseeds in the structure of sowings of the American and European agriculture is not favourable from the point of view of agrotechnics and the ecosystem's biodiversity. As a result, changes in the approach to biofuels – the production of food and the search for balance between future energy challenges and maintaining food security, should be expected. This can be achieved e.g. by the development of biofuels of further generations (from non-food raw materials). The greater their share in the production of biofuels, the lower, among others, the growth in the prices of agricultural raw materials.

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