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# Research Papers

## THE ROLE OF AGRIBUSINESS IN POLISH ECONOMY: AN ANALYSIS BASED ON THE INPUT-OUTPUT TABLES

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### Abstract

*The aim of this paper is to evaluate changes in the role of agribusiness in the Polish economy, the relationships between various spheres of agribusiness and its links with othersectors of the national economy. The research was conducted on the basis of the input-output tables for 2005, 2010, and 2015 published by Statistics Poland. The analysis also confirmed most of the relationships formulated so far between the agribusiness development path and the level of economic development of a given country. From 2005-2015, the share of agri-business in creating the gross value added of the Polish economy decreased, similarly as the role of internal turnover in the material supply of agriculture, while the food sector became the leading link in the agri-food sector. The agri-business sector also showed strong links with the other sectors of the economy. The changes in the food economy were caused by the intensified relations of this sector with the other countries, which translated into benefits from the international division of labor.*

**Keywords:** agribusiness, agriculture, food industry, input-output tables.

**JEL codes:** D24, D57, O13.

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## Introduction

Agribusiness, also known as the food economy or agri-food sector, plays an important role in the Polish economy. On the one hand, it has well-established links between its individual components, while on the other hand it is strongly correlated with other sectors of the economy.

The term "agribusiness" was first introduced into the scientific literature in 1957 by J.H. Davis and R.A. Goldberg in the study: *A Concept of Agribusiness*. According to the authors of this term, the agribusiness covers all economic activities related to the production and processing of agricultural resources and production activities on farms, followed by the storage, processing, and distribution of agricultural goods and products made from them (Davis and Goldberg, 1957). In Poland, the term of agribusiness appeared fairly recently, i.e. at the time of transition towards the market economy. The system of vertical links between the economic units involved in food production has been previously defined as the food economy, food economy complex, food complex, or agri-food sector (Woś, 1973, 1979; Woś and Zegar, 1983).

J.H. Davis and R.A. Goldberg are the authors of the first concept of agribusiness describing the relationships between various spheres making up this sector. For this purpose, the input-output method developed by the economist W. Leontief in the 1930s is used. This method enables the determination of interrelationships between the sectors of national economy involved in food production (Leontief, 1936, 1941). This formed the basis to identify the three key components of agribusiness. Sphere I includes the industries providing the means of production and services for agriculture and food industry, sphere II – agriculture, and sphere III – the food industry (Davis and Goldberg, 1957).

The input-output method is commonly used in the agribusiness research. So far, it has been the only method to analyze the volume and structure of material flows in the agri-food sector. A. Woś (1979) notes that a complete and sufficiently detailed input-output table in value terms enables the determination of material flows between the spheres of agribusiness, which in turn allows for determining the share of individual areas in agribusiness output. A. Czyżewski and A. Grzelak (2012) emphasize that the assessments made with the use of input-output balances enable and extend the research perspective, considering the importance of the examined sectors (product groups) in the economy, their macroeconomic efficiency, and interdependencies in the development process.

The precursors of using the input-output tables in the studies on interdependencies in the agri-food sector and between this sector and the other sectors of the Polish economy were A. Woś and J.S. Zegar. According to the first research conducted in the 1970s and early 1980s, the food economy in Poland was characterized by a small share of sectors and branches indirectly involved in food production (Woś, 1973, 1979; Woś and Zegar, 1983). They described this structure of the agri-food sector as typical for the early development of a food economy.

The development of the agri-food sector manifests itself in two ways, i.e. in the changes between the individual spheres of agribusiness and in the relationships between the food and national economies. The share of agriculture decreases with the socio-economic development of a country, while the role of the food industry, trading and services increases (Czyżewski, 1995). A. Zalewski (1989) notes that the evolution triggers a change in the leading link of the agribusiness from agriculture to the food industry and consumers. The increasing share of food sectors supporting the agriculture and food industry was identified by A. Woś and J.S. Zegar (1983) as early as in the late 1970s. However, the pace of changes in Poland has been slower than in industrialized countries, and slower than it would result from socio-economic development achieved by Poland. A. Woś and J.S. Zegar (1983) explained this by the retardation of the production component of agriculture as a whole. According to the authors, the factor enabling a technological breakthrough in the food economy is a well-developed production industry, which allows the use of technical innovations at all stages of food production.

The research carried out in this century confirmed the relationships referred to above. As noted by W. Poczta and A. Mrówczyńska-Kamińska (2004a), the pre-industrial economy used to be based on agriculture. Increased level of industrialization results in a higher proportion of agri-food processing and trade. The share of industries involved in providing the means of production and services for agriculture and the food industry is the most dynamic. In the post-industrial economy, the share of agriculture in agribusiness as a whole continues to decrease, while the leading role has been taken over by the food industry and trade.

The aim of this article is to evaluate changes in the role of agribusiness in the Polish economy, the relationships between various spheres of agribusiness and its links with other sectors of the national economy.

The paper consists of several parts. The first part presents the use options of the input-output tables to analyze the individual economic sectors. Then, it reviews the latest research in this area and describes the research method. In the following parts, the paper presents the research results and discussion. The last part includes a summary and conclusions.

## The concept of a national input-output table

The history of input-output tables (IOT) dates back to the second half of the 18$^{th}$ century. The economic table (*Tableau economique*) developed by the French economist Francois Quesnay was the first operating scheme of the national economy in history. The table described the simple reproduction and circulation of goods and money in the economy, taking into account the economic structure (three social classes) and circular movement in the economy (Bartkowiak, 2008). In the 19$^{th}$ century, Quesney's economic table was used by K. Marx (for the purposes of the product development and division scheme) and L. Walras (for the purposes of the general equilibrium theory). The existing form of the table and the foundations of its use were developed in the 1930s by W. Leontief (1936, p. 105-125, 1941).

M. Przybyliński (2012) emphasizes that despite the development of economic theories, no method that could be regarded as a similar breakthrough in product circulation has been developed so far.

The IOT contains a statistical description of the production activity of the individual sectors of the analyzed system (usually of a given economy) in time (usually one year). In other words, the table provides information on the process of product development and division in a given economic system with particular focus on links between the production sectors at the intermediate production stages. In general form, the IOT consists of three parts, i.e. quarters (Fig. 1).

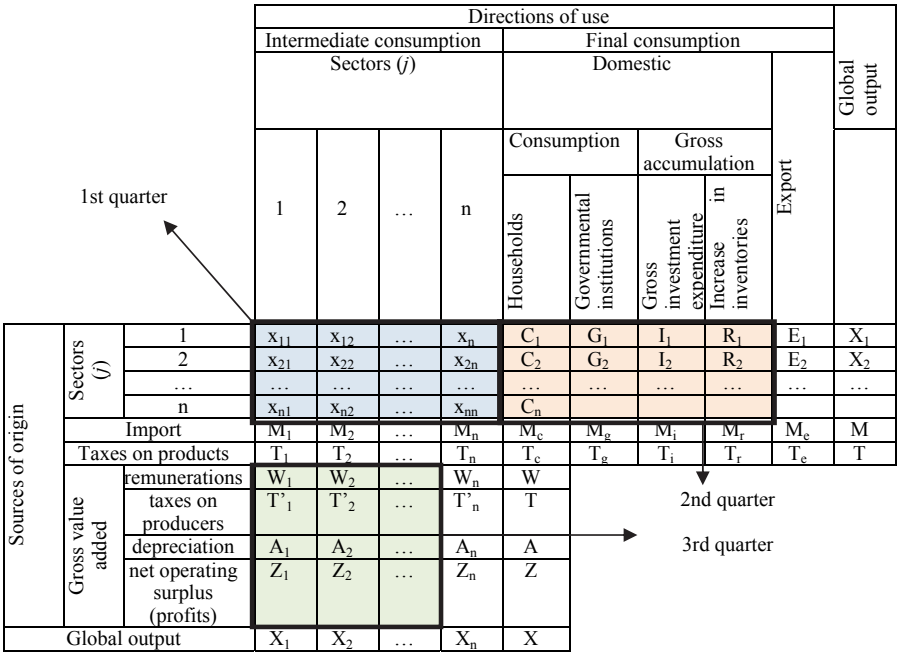



*Fig. 1.* Scheme of input-output table for domestic production

Source: own elaboration based on Statistics Poland, 2014.

The first quarter presents the intermediate goods flow. The second one describes the final goods flow, taking into account the consumption by households, non-commercial institutions, and by the governmental and local government institutions, gross expenditure on fixed assets, increase in inventories, and export. The third quarter presents the value added constituting the costs related to employment, taxes on producers less subsidies for the producers, depreciation of fixed assets and net operating surplus. The goods flows in the first quarter (also referred to as inputs-outputs) are classified by the source of origin and place of destination (Plich, 2002).

Thus, it is possible to define for each sector:

a) the origin of products consumed by the sector as the production input (analysis by columns);
b) the intended use of the products made, i.e. for further use as the production input or final consumption (analysis by lines).

The relationships resulting from IOT can be presented in quantitative terms (Miller and Blair, 2009; Plich, 2002). The analysis of columns (vertical approach) enables the formulation of equation for costs of the j sector using the following formula:

$$X_j = \sum_{i=1}^{n} x_{ij} + M_j + V_j \tag{1}$$

and

$$V_j = W_j + T_j + A_j + Z_j, \tag{2}$$

where:

$X_j$ – global output of the *j* sector,
$x_{ij}$ – flow from the *i* sector (line in input-output balance) to the *j* sector (column in the input-output balance,
$M_j$ – value of imported materials used for production of the *j* sector,
$V_j$ – gross value added produced in the *j* sector,
$W_j$ – costs of employment in the *j* sector,
$T_j$ – taxes on producers less subsidies for the producers in the *j* sector,
$A_j$ – depreciation of fixed assets in the *j* sector,
$Z_j$ – net operating surplus in the *j* sector,
$i, j$ – economic sectors.

In other words, the value of output in a given sector is the total of intermediate consumption of the imported materials and gross value added.

The analysis of individual lines of IOT (horizontal approach) allows the formulation of division (distribution) equation for the i sector output in the form of the following formula:

$$X_i = \sum_{j=1}^{n} x_{ij} + Y_i \tag{3}$$

and

$$Y_i = C_i + G_i + I_i + R_i + E_i \tag{4}$$

where:
$Y_i$ – production value intended for final consumption,
$C_i$ – consumption of households and non-commercial institutions supporting households,
$G_i$ – consumption of government and local government institutions,
$I_i$ – gross expenditure for fixed assets,
$R_i$ – increase in inventories and assets of unique value,
$E_i$ – export.

The mathematical description of relationships included in the IOT is called the input-output model. The basic balance equation of the national IOT for the n-sector economy is as follows (Miller, Blair, 2009):

$$\boldsymbol{X} = \mathbf{A}\boldsymbol{X} + \boldsymbol{f}, \tag{5}$$

where:
$X$ – vector ($n \times 1$) of global output,
$A$ – matrix ($n \times n$) of technical and financial coefficients, also referred to as the cost structure matrix,
$f$ – vector ($n \times 1$) of final demand.

Matrix $\mathrm{A} = [a_{ij}]_{n \times n}$ includes the coefficients of direct input intensity of the global output calculated from the following formula (Statistics Poland, 2019):

$$a_{ij} = \frac{x_{ij}}{X_j}, \tag{6}$$

where:
$a_{ij}$ – direct input intensity coefficient of the global output, meaning the value of products (goods and services) from the $i$ sector and used directly by the $j$ sector to produce the output value unit in the $j$ sector;
$x_{ij}$ – value of products made in the $i$ sector and used in the $j$ sector;
$X_j$ – global output of the $j$ sector.

After converting the equation (1) with the use of unitary matrix **I**, we receive the equation called the Leontief model (Miller and Blair, 2009, p. 22):

$$(\mathbf{I} - \mathbf{A})\boldsymbol{X} = \boldsymbol{f}, \tag{7}$$

where matrix **I – A** is referred to as the Leontief matrix and converts the output vector X into the final output vector f, and then into the following equation:

$$\boldsymbol{X} = (\mathbf{I} - \mathbf{A})^{-1}\boldsymbol{f} = \mathbf{L}\boldsymbol{f}, \tag{8}$$

where $(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{L}$ is the matrix (n×n) of the total product input coefficient (or additional demand) of the final output, also referred toas the Leontief inverse matrix.

Matrix **L** converts the final output vector ***f*** in the output vector ***X***. The elements of matrix $\mathbf{L} = [l_{ij}]_{n \times n}$ specify the value by which the *i* sector output should be increased to ensure that the output meeting the demand for final goods in the *j* sector increases by one unit.

The input-output tables enable the calculation of the direct import intensity coefficient of the sectoral output. Matrix B = [bij] n×n includes the direct import intensity coefficients of the sectoral output calculated from the following formula (Statistics Poland, 2019):

$$b_{ij} = \frac{m_{ij}}{x_j}, \tag{9}$$

where:

$b_{ij}$ – direct import intensity coefficient of the global output, meaning the value of imported products (goods and services) in the i sector, which are used directly by the sector to produce the output value unit in by the j sector;

$m_{ij}$ – value of flow of imported products made in the i sector and used in the j sector.

Matrix B can be converted into the form including the coefficients of total import intensity using the following formula (Statistics Poland, 2019):

$$\mathbf{B}' = \mathbf{B} * (\mathbf{I} - \mathbf{A})^{-1} \tag{10}$$

where:

$b'_{ij}$ – total import intensity coefficient of the final output, meaning the value of imported products (goods and services) used directly by the *j* sector and indirectly by all cooperating sectors to achieve the final output of a unit value.

Another measure is the direct value added share coefficient of the global output. The vector includes the coefficients for all economic sectors, calculated according to the following formula:

$$\boldsymbol{v_j} = \frac{V_j}{X_j} \tag{11}$$

where:

$v_j$ – direct value added share coefficient of the global *j* sector output.

Vector $\boldsymbol{v} = [v_j]_{1 \times n}$ can be converted into vector $\boldsymbol{v'} = [v'_j]_{1 \times n}$ including the total value added share coefficient, according to the following formula:

$$\boldsymbol{v'} = v * \mathbf{L} \tag{12}$$

where:

$v'_j$ – total value added coefficient in the j sector output, meaning the gross value added generated directly and indirectly in the economy as a whole as a result of producing a final output unit value in the *j* sector of the economy.

When totaling the components of matrix **L** by columns, we will receive an aggregate of the coefficients of the total import intensity (also referred to as the total input intensity) of final output in the individual sectors of the economy. These coefficients determine the total inputs of the individual production factors (domestic materials, imported materials, labor, services, and capital) necessary to generate the final output unit in a given economic sector. In other words, for a given sector of the economy, the aggregate total input intensity coefficient of the final output is the total of three components: the aggregate total input intensity coefficients referring to domestic inputs, the aggregate of total import intensity coefficients referring to production, and the total gross value added share coefficient. For each sector, the total of the two latter components is equal to one.

The equations presented above do not exhaust the opportunities created by the national IOTs in the area of research on the structural changes of the economies. With regard to the economy of Poland, these opportunities have been used in numerous studies (including among others Marczewski, 1980; Marczewski and Wysocka, 2000; Wyżnikiewicz, 1973).

In the first half of the 21st centurty, several databases containing the global input-output tables were made available. The most commonly used databases include the following: OECD's Trade in Value Added database and World Input-Output Database (WIOD Release, 2016). On one hand, the global IOTs allow more detailed research of correlations with the other countries, while on the other hand they have certain limitations. The most important include a more aggregated layout of the economic sectors, which prevents an in-depth analysis of agribusiness (Ambroziak, 2018b, pp. 26-28).

## Research review

In this century, the agribusiness in Poland has become the subject of many analyses that use the input-output tables, or other national tables, including the supply and use table. The subject of research was the material flows in the Polish agri-food sector and its correlations with the national economy (Mrówczyńska-Kamińska and Poczta, 2009; Poczta and Mrówczyńska-Kamińska, 2004a), agricultural flows (Poczta and Mrówczyńska-Kamińska, 2010), or food industry flows (Poczta and Mrówczyńska-Kamińska, 2004b). Comparisons between the agribusiness (as a whole or of its individual components) in Poland and Germany were also frequent (Mrówczyńska-Kamińska, 2012; Mrówczyńska-Kamińska and Czyżewski, 2011).

Another subject of research was also the role of agribusiness (or its components) in Poland compared with the other EU Member States (Mrówczyńska-Kamińska, 2009, 2013, 2015; Baer-Nawrocka, and Mrówczyńska-Kamińska, 2019).

The research conclusions point out at differences in business structure between countries with a high level of economic development (EU-15 countries, including Germany) and the less developed countries (new EU Member States, including Poland). In the former countries, the sector providing the means of production and services (sphere I), and food processing (sphere III) plays an important role

in the material supply of agriculture, while the level of internal trade is low. In less developed countries, including Poland, the dominant role in agriculture is played by the internal resource production, i.e. the internal trade. Strengthening the impact of global processes on the development of the Polish agri-food sector as a whole requires an increased importance of export and import in the production and distribution of demand for food industry products.

In addition, A. Baer-Nawrocka and A. Mrówczyńska-Kamińska (2015) studied the relationship between the income in agriculture in the EU Member States and material flows in this sector. A. Czyżewski and L. Kryszak (2016) analyzed the input-output interdependecies with respect to agriculture in the context of the amount of financial support for this sector in the ten selected non-EU states. This research demonstrated a moderate relationship between the income in agriculture and the rate and structure of material flows to agriculture. This may increase the dependency of income from subsidies within the CAP in the EU Member States. The performed analyses confirmed the development paradox of agriculture, according to which high capacity of the agricultural sector is linked with a relatively low macroeconomic efficiency and at the time time high labor efficiency. (Czyżewski and Kryszak, 2016).

In addition, Ł. Ambroziak (2017) use the global input-output tables from the WIOD Release 2016 to study the role of the food industry in Poland and export of products from this industry with a view to the domestic and foreign value added (2018a; 2018c). The most comprehensive analysis of agribusiness in Poland compared with the other countries (with the use of WIOD) was performed by J.Góral, A. Mrówczyńska-Kamińska, and C. Klimkowski (2017). The analysis covered, among others, the changes in the role of agribusiness in the national economy, flows between the individual spheres of agribusiness, as well as the changes in the structure of production and distribution of output in the agri-food sector. The analysis of historical data is supplemented by the input-output projection in the Polish agribusiness after 2020 with a view to the experiences of the other countries. The projections indicate a declining role of self-sufficiency of agriculture in total supplies to this sector as well as an increasing importance of means of production from the other sectors of the economy, including in particular services – for example, legal, accounting, lease of capital goods, job assistance, as well as financial and insurance services.

## Materials and methods

The presented research continues the studies of the Polish food industry carried out by the author in 2017 with the use of WIOD Release 2016 (Ambroziak, 2017). The analysis covers the years 2005, 2010, and 2015, i.e. the most up-to-date data from the input-output tables. The source of data is the Statistics Poland. Contrary to the global IOTs, the national tables allow for a detailed analysis of the agri-food sector (77 sectors identified). The analysis covers four sections of the Polish Classification of Business Activities (instead of the food industry alone as previously)

of the agri-food sector: agricultural and hunting products (01), food products (10), beverages (11), and tobacco products (12). The scope of the research refers to the conventional division of agribusiness into three spheres. Sphere I covers the industries providing the means of production and services for agriculture and food industry, here understood as the three separate sections of the Polish Classification of Business Activities, i.e. production of food products, beverages, and tobacco products. Sphere II includes agriculture, while sphere III is the food industry, consisting in the three above-mentioned sections. Traditionally, the production of beverages and tobacco products has been analyzed together with the production of food products. Although the first two sections have a minor share in the agri-food sector, they are different from the production of food products, which is why they were separated. The only exception is the year 2015, for which the aggregate data for food products and beverages were provided.

The research was conducted with the use of relationships and equations presented in chapter 1. These included in particular: the equation of global output costs (1,2), the equation of global output division (distribution) (3,4), the coefficients of direct input intensity of the global output (6), the coefficients of total input intensity of the final global output (9), the coefficients of direct total gross value added share of the final global output (12)[1]. One should note that the coefficients used in the analysis reflect the state for the given year, i.e. they consider no changes in the structure of materialsupply in the agriculture and food industry in a long-time perspective.

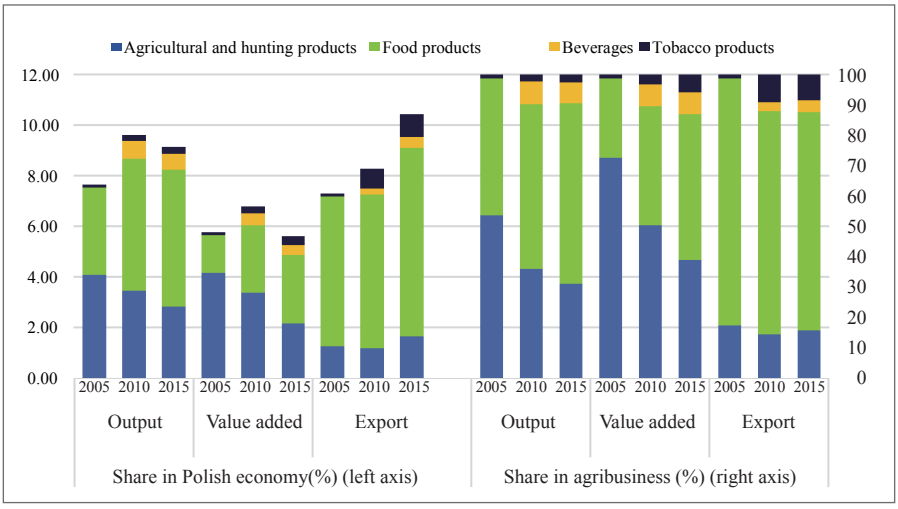
## Results

### *The role of agribusiness in the national economy*

The role of agribusiness in the Polish economy was evaluated with the use of three economic categories: output, gross value added and export. In 2015, the agri-food sector accounted for 9.13% of the global output produced in the national economy (increase by 1.48 p.p. comparing to 2005), and for 5.61% of gross value added (decrease by 0.14 p.p.)[2]. The increased share of agribusiness in the global output and the decreased gross value added from 2005-2015 indicate a declining share of value added in the global output unit. In the studied period, the share of agribusiness in the Polish export (of goods and services) gradually increased. In 2015, it amounted to 10.41% and was higher by 3.11 p.p. than in 2005.

[1] A similar method was applied by K. Marczewski in the study on the role of automotive industry in Poland (ARR, 2017).

[2] However, comparing to 2010, the share of agri-food sector decreased both in the global output and gross value added..




*Graph 1.* The role of agribusiness in the Polish Economy.

Note: In 2005, data on food products were aggregated with data on beverages.

Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

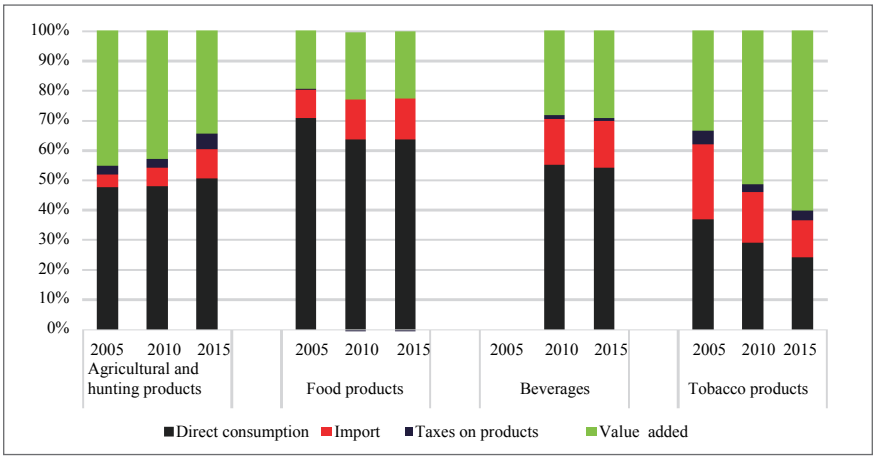
Significant changes were observed in the structure of the agri-food sector. In the analyzed period, the food industry became the leading link. Its share in the output and gross value added of both agribusiness and the Polish economy as a whole increased. The position of food products in Polish exports (of goods and services) strengthened, although their share in export from the agri-food sector decreased. In 2015, the food industry accounted for 59.3% of the output, 48.3% of gross value added, and 71.7% of export from the agribusiness. The role of agriculture and hunting (hereinafter: agriculture) in the agribusiness declined in all three economic categories. In 2015, agriculture generated 31.4% of the global output, 39.1% of gross value added, and 15.9% of export from the agribusiness. With regard to the share of agricultural products in total Polish exports, it improved slightly in the analyzed period. The role of tobacco products increased in the agri-food sector, including in particular in export. In 2015, these products accounted for 8.3% of export, 5.5% of gross value added, and 2.5 of the global output in the whole agribusiness sector.

### *The balance of production and distribution of the global agri-business sector output*

According to the global output balance for the four economic sectors linked with the agri-food sector, from 2005-2015, the share of costs of domestic materials (i.e. material supply from all three spheres) in the food product and tobacco product output decreased by 6.9 p.p. and 12.7 p.p., respectively, increased for the agricultural and hunting products (by 2.9 p.p.) and remained stable for beverages (for 2010-2015) – Graph 2. In 2015, the costs of domestic materials were of the greatest

importance in the production of food products and accounted for 64% of the global output value in this sector. Their high share was also recorded for beverages (55.3%) as well as the agricultural and hunting products (50.8%). The domestic inputs played the smallest role in the tobacco product output. They accounted for merely 24.5% of the global output in this sector.

In the studied period, the share of costs of imported materials in the global food product output increased (by 4.3 p.p. from 2005-2015), as well as of agricultural and hunting products (by 5.5 p.p.). The observed drop in the share of imports in the global tobacco product output is surprising. Between 2005 and 2015 it went down from 25.2 to 12.1%. According to the results of other studies, the development of the tobacco industry in Poland depends primarily on imported resources (Szczepaniak, 2019). The commercial data also demonstrate that the import of tobacco increased from 2005-2015 by 3.4 times, reaching EUR 0.5 billion in 2015.




*Graph 2.* The agribusiness output balance (%).

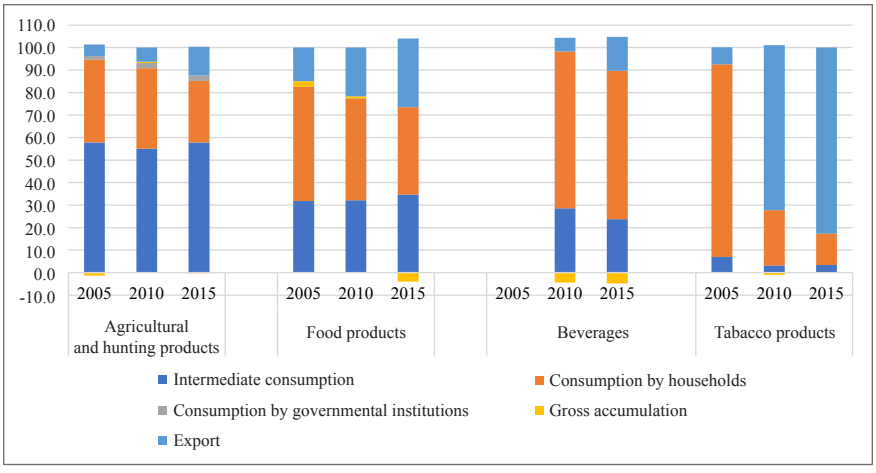
Note: In 2005, data on food products were aggregated with data on beverages.

Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

The derivative of the role of costs of the domestic and imported materials is the share of value added (the total of remuneration costs, operating surplus and taxes on producers less the producer subsidies) in the global output. Apart from the agricultural and hunting products, the role of value added in the remaining sectors of agribusiness in the analyzed period gained importance. The highest increase, nearly twofold, was recorded in the global tobacco product output. In 2015, this accounted for nearly 60% of the global output in this sector3. The share of value added in the production of beverages was lower by more than a half; it accounted for 29.1% (by 1.1 p.p. more than in 2005). In the production of food products, this share amounted to 22.3% (by 3.1 p.p. more). Despite a drop by 11 p.p.

from 2005-2015, the share of value added in the agricultural and hunting product output continued to be relatively high and amounted to 34%.

From 2005-2015, greater changes were observed in the output distribution balance of the individual agribusiness sectors (Graph 3). Intermediate consumption was mainly based on the agricultural and hunting output. In the analyzed period, this share remained stable. In 2015, nearly 58% of the global output from this sector was consumed in all sectors of the economy, primarily in the food industry. The share of intermediate consumption in the distribution of output from the food industry grew slightly by 2.8 p.p. (in 2015, 34.7% of output from this sector was allocated for this purpose). The importance of final consumption in the distribution of the global beverage and tobacco product output declined. In the latter sector, in 2015 only 3.4% of output was consumed by the whole economy (by 3.5 p.p. less than in 2005).




*Graph 3.* Agribusiness output distribution balance (%).

Notes: 1) In 2005, data on food products were aggregated with data on beverages.

2) Gross accumulation includes gross expenditure on fixed assets (i.e. investments) and increase in inventories and assets of the unique value (i.e. inventory change). The second component frequently demonstrates a negative value, which translates into a negative gross accumulation value in some years.

Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

It should be noted that the structure of gross value added changed significantly in the analyzed period. The share of remunerations in creation of gross value added in this sector decreased from 36% in 2005 to merely 13% in 2015, while the share of net operating surplus rose from 40 to 62% (Statistics Poland, 2009, 2019).

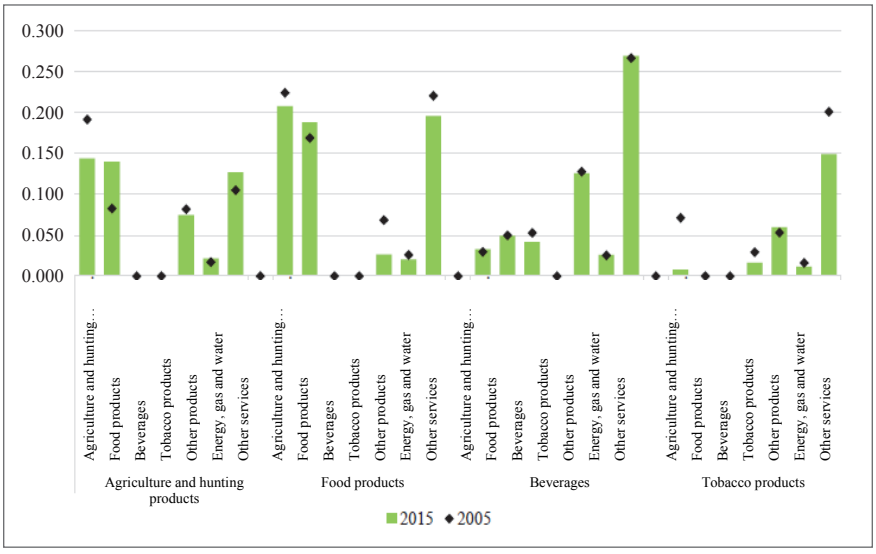
In all economic sectors, the share of global output used for household consumption decreased, while the exported output increased. The greatest changes in this area were observed for tobacco products. From 2005-2015, the share of private consumption in the global output fell from 85.7% to 13.9%. At the same

time, the share of exports grew from 7.5% to 82.7%. In the food industry, the share of household consumption in the output decreased by 12 p.p. in the analyzed period (down to 38.8% in 2015). The share of relevant output exports increased by 15.4 p.p. In 2015, 30.4% of the global food industry output was exported. Despite a clear increase, the role of exports in the distribution of agricultural and hunting output, as well as of beverage output, was minor. In 2015, 12.8% and 15.1% of the output from these economic sectors was exported, respectively. Nearly 3/4 of output is allocated for household consumption. According to the research results, the development of the Polish agri-food sector switches from final domestic demand to export. These conclusions are confirmed by the other studies. According to I. Szczepaniak and J. Drożdż (2021), the determinant for the food industry development in the last years was mainly export demand, supported by domestic demand that increased at a slower pace. This is confirmed by the growth in the sold output of the food industry and increase in the export of food industry products by nearly 54% (from 2010-2014 the rates amounted to 15 and 93%, respectively).

***Changes to the input intensity in the agribusiness sector***

*Domestic materials*

When producing the output, the agriculture and hunting sector uses, with reference to domestic inputs, primarily the products made by this sector (flow from sphere II) and by the food industry (flow from sphere III) – Graph 4. From 2005-2015, the share of agricultural and hunting products decreased, while the sector of food products witnessed a growth. A slight decline was also observed in the share of the other industrial processing products (other than food products), and the share of services, which had a relatively high importance for global agricultural output, increased. In 2015, the increase in agricultural output by one unit (in value terms) required an output increase in this sector by 0.144 units (by 0.048 unit less than in 2005), increase in the food industry output by 0.140 units (by 0,057 unit more), and in the output of other industrial processing sectors by 0.075 units (by 0.034 unit less). In the latter group, the chemicals and chemical products, as well as coke and refined petroleum products, were of the greatest importance. In addition, the increased agricultural output by one unit resulted in the demand for output in the service sectors by 0.148 unit (by 0.026 unit more). The greatest importance was attributed to wholesale and retail trade, financial and insurance activity, and road transport. The conclusions comply with the agriculture development path described in the literature (e.g. Woś and Zegar, 1983).




*Graph 4.* Coefficients of direct input intensity of the global agribusiness output.
Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

The structure of domestic materials used for production of food products demonstrated that the dominant role was played by the products derived from this sector the so-called intra-sectoral cooperation (flows from sphere III) and the agricultural and hunting products (flows from sphere II). In 2015, the production of one output unit in the food product sector required 0.188 unit of products from this sector and 0.208 unit of the agricultural and hunting products. When comparing with 2005, the role of agricultural and hunting products decreased (by 0.016 unit), while that of food products rose (by 0.017). In the analyzed period, there was also a decrease in the role of the other products and services (flows from sphere I) in the output of this sector (by 0.042 and 0.031 unit) observed. In 2015, a growth in food product output by one unit required the increase in output of the remaining products by 0.027 units, while of services by 0.216 units (including 0.020 global output units in the sectors linked with water, gas, and energy supplies). From among the sectors, in which the products are made or acquired, paper, plastic, and chemical products were of the greatest importance in the production of food products. In services, the food industry demonstrated the strongest cooperative relations with such sectors as wholesale and retail trade, and road transport.

The production of beverages used relatively low quantities of products from the agri-food sector. In 2015, the production of one output unit in this sector required 0.124 units (slightly less than in 2010) of products from the agri-food sector. The dominant domestic materials included the services and other products (flows from sphere I). In 2015, increase in beverage production by one unit required an increase in their output by 0.293 and 0.126 units, respectively. The cooperative rela-

tions of the beverage production with such sectors as production of metal products, rubber products and plastics, paper products and other non-metallic raw materials, were particularly strong.

In the services sector, the greatest importance in the beverage output was attributed to: advertising and market research services, wholesale trade, retail trade, road transport and storage.

Between 2005 and 2015, the role of domestic materials from the agri-food sector used for production of tobacco products decreased more than four times. In 2015, the increase in global output by one unit was linked with an increase in the agri-food sector output by only 0.024 units (compared with 0.101 units in 2005). Despite a decline, the highest share in global output was attributed to service, including in particular advertising market research services, business services, wholesale and retail trade, storage and transport. In 2015, the increase in the global tobacco product output by one unit required an increase in the global service output by 0.161 unit (comparing to 0.218 unit in 2005). In the analyzed period, the direct input intensity coefficient increased slightly with reference to the other products. In 2015, it amounted to 0.060 (comparing with 0.053 in 2005), which resulted from the use of paper and paper products.

Taking into account direct and indirect inputs from the individual sectors gives a more complete image of cooperative relations of the agri-food sector with the other sectors of the economy. These interdependencies can be illustrated by the coefficients of total input intensity of the final output. These provide information on the value of materials from the individual sectors consumed directly and indirectly in the whole national economy for the purposes of sectoral output (i.e. intended only for final purposes, i.e. consumption, investments or export) of a unit value. In other words, these coefficients enable the entire economic system to be covered and estimate the direct and indirect effects (by means of cooperative relations) of increasing the final output in a sector by one unit for the whole economy.

For each part of the agri-food sector, the coefficients of total input intensity of the final output can be totaled and then the value of aggregate total import intensity coefficient and value added share coefficient (approximately 1) can be subtracted. The received value is interpreted as the changes in the value of domestic inputs in the economy as an effect of increase in the final output (final demand) in a given sector by a value unit. In 2015, the greatest input intensity was recorded in final output of food products. The increase in final demand in this sector by one unit required an increase in the global output by 1.249 units (by 0.146 less than in 2005) – Graph 6. For the agricultural and hunting products, this coefficient amounted to 1.026 in 2015 (by 0.075 more than in 2005), while for beverages it was 0.989. The lowest coefficient values were recorded for tobacco products. Increase in the final demand for these products by one unit caused an output increase by 0.454 units (by 0.253 unit less than in 2005).

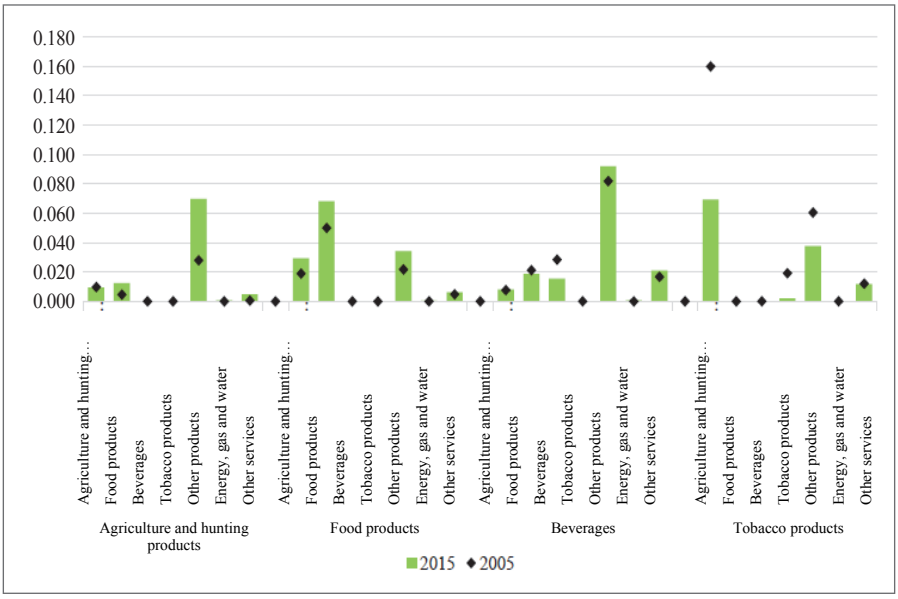
*Imported materials*

The highest demand from agriculture for imported materials was recorded for other (than food products) industrial processing products, including in particular chemical substances and products, as well as machinery and equipment (Graph 5). In 2015, the increase in agricultural output by one unit caused an increase in the import of other products by 0.07 units comparing to 0.028 units in 2005.

The food industry benefits, similarly as in the case of domestic materials, primarily from the imported materials produced in this sector and from the agricultural and hunting products. However, the direct import intensity coefficients are clearly lower than the direct input intensity coefficients. Increased food product output by one unit in 2015 resulted in growing demand for imports in this sector by 0.068 units, and of agricultural and hunting products by 0.029 units (an increase in the analyzed period was observed for both groups). With regard to the other products, the greatest role for output was played by: chemical substances and products, fish, paper and paper products, and rubber and plastic products. In the case of fish, the direct import intensity coefficient increased between 2005 and 2015 from 0.003 to 0.013, which may be associated with a rapid development of salmon processing.

The structure of imported materials used for beverage production was similar to the structure of domestic materials. Relatively low importance was attributed to the products from the four parts of the agri-food sector (a direct import intensity coefficient of 0.042 in 2015). The importance of the other products was more than twice greater (a coefficient value of 0.092). With regard to the imported materials, the tobacco industry used mostly agricultural and hunting products. Between 2005 and 2015, the direct import intensity for this sector decreased from 0.160 to 0.069, although it was still higher than for the domestic agricultural and hunting products (in 2015 it amounted to merely 0.008). The important imported products also included other products, mostly paper and paper products, and chemical products. The tobacco product output of a value of one unit required 0.038 import units of these products.

The input-output model also enables the determination of the total import intensity coefficient of the final output. The coefficients for the individual agribusiness sectors were calculated. These coefficients show by what value the import in the economy as a whole will increase, if the final output in a given sector (i.e. meeting the final demand) increases by one unit. In 2015, the highest coefficients were calculated for the food products and beverages. Increase in the final output of these sectors by one unit caused the import growth in the economy by 0.28 units. Lower import intensity was observed for the agricultural and hunting products (0.224 units), while the lowest was for the tobacco products (0.171).



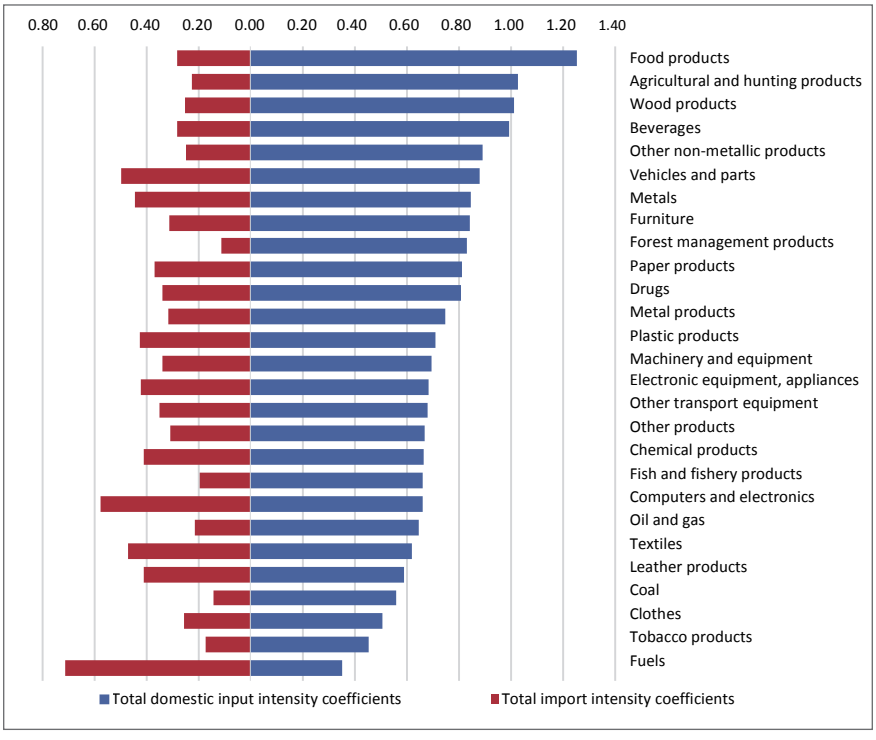

*Graph 5.* Coefficients of direct import intensity of the agribusiness output.
Note: In 2005, data on food products were aggregated with data on beverages.
Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

## *The agribusiness sector and other sectors of the national economy*

When compared with the selected economic sectors, the output of food products demonstrated the highest total input intensity coefficient with regard to domestic materials (1.249). This points towards the strong cooperative relations of this sector with the other economic sectors. The economic sectors with very high total domestic input intensity coefficients also included agriculture and hunting (1.0264), as well as beverage production (0.989). The production of tobacco products demonstrated one of the weakest links with the other sectors of the economy.

The economic sectors related to the food sector – compared to the other parts of the economy – featured relatively low total import intensity coefficients of the final output. A relatively low input intensity cannot be analyzed only in terms of benefits and gains. It may prove the unused import capacity in agribusiness development that is, for example, the inflow of new technologies.

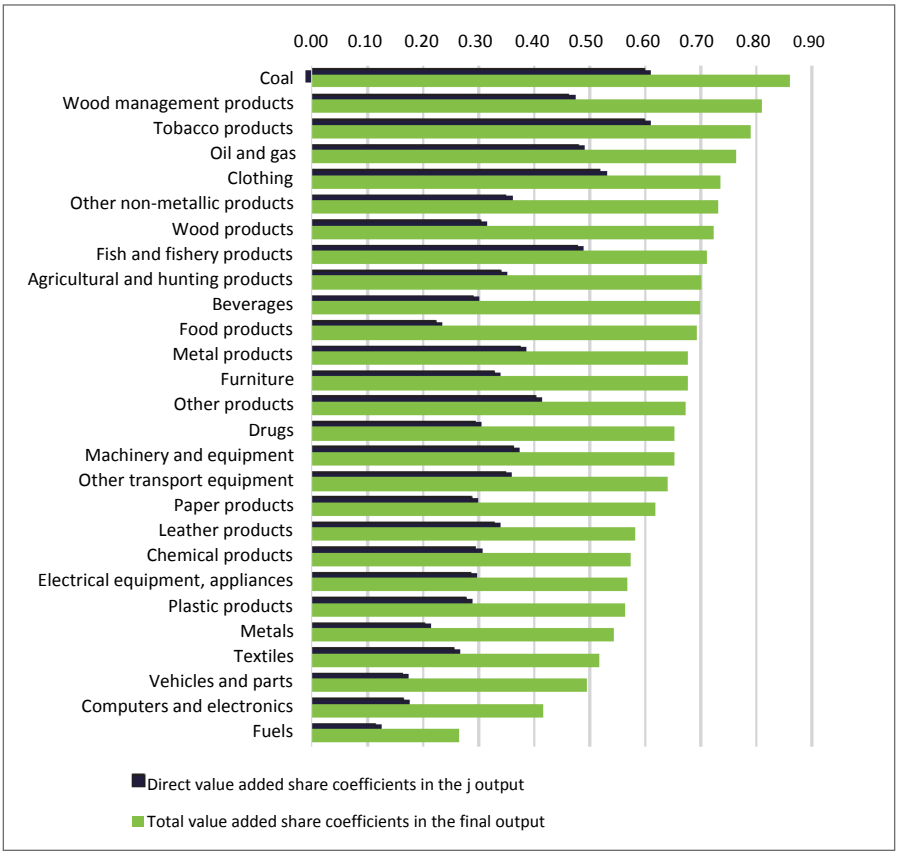
The direct gross value added share coefficients in the agribusiness sector output differ significantly (Graph 7). The unit output of the tobacco products sector generated a gross value added of 0.6 unit. The unit output of the agricultural and hunting products generated nearly a half lower value added (0.340), similarly to beverages (0.291). The lowest value added was generated from the unit of the global food products output – only 0.223 unit.




*Graph 6.* Total input intensity coefficient with regard to domestic products and total import intensity coefficients of the final output of the selected economic sectors in 2015.

Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

In order to evaluate how much gross value added is generated directly and indirectly in the whole economy as an effect of production in a given economic sector of final output of unit value, one should compare the total gross value added share coefficients in the final output. According to the performed analysis of these coefficients for the individual economic sectors in 2015, the agri-food sectors demonstrated a relatively high share of gross added value in the final output. The highest coefficient was observed for the production of tobacco products, in which the unit final output contributed to the production of 0.788 value added units in the whole economy. Slightly lower, yet still high, coefficients were observed in the remaining three described sectors – agricultural and hunting products (0.700), beverages (0.698), and food products (0.691).




*Graph 7.* Direct and total value added share coefficients in the selected economic sectors in 2015.
Source: own elaboration based on data from Statistics Poland (2009, 2014, 2019).

## Discussion

The analysis confirmed the vast majority of patterns formulated so far and referring to the development path of the agribusiness, including different stages of economic development of a country (among others Woś and Zegar, 1983; Poczta and Mrówczyńska-Kamińska, 2004a; Czyżewski, 1995). The research demonstrates that the changes taking place in 2005-2015 mean that the Polish agribusiness sector becomes more and more like the agri-food sector in well-developed countries. The share of agribusiness in the creation of gross value added (contribution to GDP) of the Polish economy decreased, and the food industry became a dominant link within this sector. This reflects the reorganization and modernization taking place in the industry since the early 1990s, initially as a result of economic transformation and later as an effect of preparations to the accession and membership in the EU, or the inflow of foreign direct investments (Szajner and Szczepaniak, 2020). The analysis demonstrated that the intensification of links between the food

industry with the other countries was a significant change factor. On one hand, the increased import intensity of the global output contributes to inflow of more technologically advanced inputs, as well as processing inputs from abroad, which would be otherwise unavailable.

On the other hand, the increase in sales on the foreign market results in a growing demand for food produced in Poland and triggers further development of the food industry. The benefits for food industry development related to the increased import intensity are also indicated by A. Baer-Nawrocka and A. Mrówczyńska-Kamińska (2019).

The research demonstrates that the favorable changes also occurred in agriculture. The role of internal trade in the material supplies to this sector decreased significantly. In 2015, raw materials production within this sector (sphere II) equaled with supplies from the food industry (sphere III). The role of services which – apart from means of production – are regarded as the material supplies that cause changes in the agriculture also gained in importance (Mrówczyńska-Kamińska, 2012, 2013).

The actual role of agribusiness for the national economy is greater than demonstrated by data on the value added created directly in this sector. The input-output process also has an indirect impact on the creation of added value in the other sectors of goods production and services. A. Woś (1979) notes that the input-output channels cause a loopback effect in the agribusiness. As a result, the increase in the gross value added in the agri-food sector stimulates the positive serial linkage in the other economic sectors and production growth in the national economy.

## Conclusions

The use of input-output tables allowed for the analysis of changes in the agribusiness sector in Poland and its links with the national economy. The analysis demonstrated that between 2005 and 2015 the food industry became the leading link of the agribusiness. Its share in the national economy output and gross value added, as well as in the export of goods and services, increased. The importance of agriculture and hunting decreased in all three categories. Tobacco products gained in importance, in particular in exports.

Changes were also observed in the structure of agriculture and food industry supplies. The role of material flows from sphere II (agriculture) decreased, while flows from sphere III (food industry) increased. In the global food product output, the share of products and services from other economic sectors declined (sphere I), while agriculture recorded a slight growth. In general, the changes follow the agribusiness development path specified in the literature, which is associated with subsequent stages of economic development.

The changes in the agri-food sector were undoubtedly stimulated by the increasingly strongest connections of the individual agribusiness sectors with abroad. On the one hand, the share of imported materials (investment goods and resources) in the production structure increased. On the other hand, an increasing share of

output was intended for export. Thus, the agri-food sector in Poland benefited from the international division of labor.

The agri-business sector, including in particular the food sector, also has strong cooperative relations with the other sectors of the Polish economy. Increase in final demand for food products by one unit resulted in higher output in the economy by 1.25 units in 2015. For agriculture and beverages, these coefficients were close to 1.00.

Compared with other sectors, the final output of the agribusiness had also a relatively great impact on the creation of gross value added in the whole economy.

The global input-output tables published in recent years and describing the interrelations in the global economy may be used to deepen the analysis performed in this paper. The tables enable, among others, the identification of the sources of materials import, the direction of both exports of such materials and final output.

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# ZNACZENIE AGROBIZNESU W GOSPODARCE POLSKI: ANALIZA Z WYKORZYSTANIEM TABLIC PRZEPŁYWÓW MIĘDZYGAŁĘZIOWYCH


## Abstrakt

*Celem artykułu jest ocena zmian znaczenia agrobiznesu w gospodarce Polski, zależności pomiędzy poszczególnymi sferami agrobiznesu oraz jego powiązań z pozostałymi działami gospodarki narodowej. Badanie przeprowadzono na podstawie tablic przepływów międzygałęziowych z lat 2005, 2010 i 2015, opublikowanych przez Główny Urząd Statystyczny. Przeprowadzona analiza potwierdziła większość dotychczas sformułowanych zależności między ścieżką rozwoju agrobiznesu a poziomem rozwoju gospodarczego danego kraju. W latach 2005-2015 zmalał udział agrobiznesu w tworzeniu wartości dodanej brutto polskiej gospodarki, przemysł spożywczy stał się wiodącym ogniwem sektora rolno-spożywczego oraz zmalało znaczenie obrotu wewnętrznego w zaopatrzeniu materiałowym rolnictwa. Sektor agrobiznesu wykazywał też silne powiązania z pozostałymi działami gospodarki. Do zmian w gospodarce żywnościowej przyczyniła się intensyfikacja powiązań tego sektora z zagranicą. Pozwoliło to odnieść korzyści wynikające z międzynarodowego podziału pracy.*


**Słowa kluczowe:** agrobiznes, rolnictwo, przemysł spożywczy, tablice przepływów międzygałęziowych.

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