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THE CONCEPT OF THE RESEARCH INTO STRUCTURAL DETERMINANTS OF SUSTAINABLE AGRICULTURAL INTENSIFICATION IN EUROPEAN UNION COUNTRIES

JEL codes: E01, Q01, Q19

Summary: The aim of the study is to present the issues of research on sustainable intensification of the agriculture, in the specific context of the European Union and to present research procedure for such study. Proposed framework is based on the use of Eurostat data, to conduct efficiency (DEA) and productivity (Malmquist TFP index) analysis, to estimate the sustainable intensification index. Further structural determinants of this process might be assessed by means of panel regression. On the basis of the literature review carried out, the study may be limited to testing the impact of concentration, specialisation and orientation of agricultural production. As control variables, those describing endogenous, exogenous and institutional conditions should be included in the study.

Key words: sustainable intensification, eco-efficiency, structural change.

1. INTRODUCTION

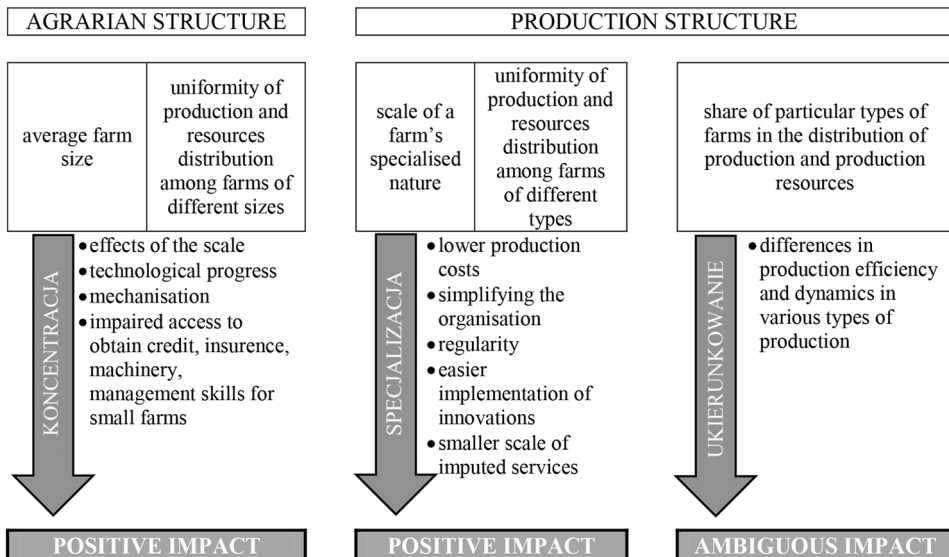
The concept of sustainable agricultural intensification (SI) appeared at the end of the 1990s as a response to growing food supply needs of the world and an increase in pressure on the environment. It was found that increasing food production must be accomplished by intensifying the use of existing environmental resources as the conversion of subsequent resources to agricultural needs may lead to the imbalance of the global ecosystem [Pretty 1997]. After twenty years, this problem is as applicable today as it was then. In 2016, 815 million people still suffered from malnutrition [FAO, IFAD, UNICEF, WFP and WHO 2017], even despite the growth of greenhouse gas emissions from agriculture in years 1997-2016 by nearly 16% [FAOStat 2018]. Such circumstances raise numerous questions concerning SI. Is it possible at all to achieve economic and environmental objectives at the same time? What approach should be taken with regard to sustainable intensification in Poland and

other European Union countries? Is there any way to stimulate the process of sustainable intensification?

In the context of the first of the questions posed, the current studies have been conducted mainly in the microeconomic perspective [Weltin et al. 2018]. Researchers have demonstrated the potential of increased production capacity while maintaining or reducing the environmental impact illustrated by specific technologies applied under particular conditions. The question whether these possibilities can be revealed on a larger scale remains open. Is it possible to identify sustainable intensification at the level of the agricultural sector which would prove the legitimacy of pushing this concept also in the implementation of agricultural policy?

The interpretation of the concept of sustainable intensification in the EU context is questionable as well. Considering the fact that EU agriculture is already among the most intense ones in the world, researchers suggest focusing on balancing (greening) the production methods [Buckwell et al. 2014] so that to contribute to the reduction of the global pressure on the environment. However, according to the assumptions of sustainable intensification, this reduction should not be achieved by decreasing production, which is contrary to the objective of maintaining food security. Therefore, it is required to improve production eco-efficiency (environmental effectiveness), namely, to minimize the negative impact (environmental footprint) per unit of production [Garnett, Godfray 2012]. The concept of eco-efficiency can be used to measure sustainable intensification.

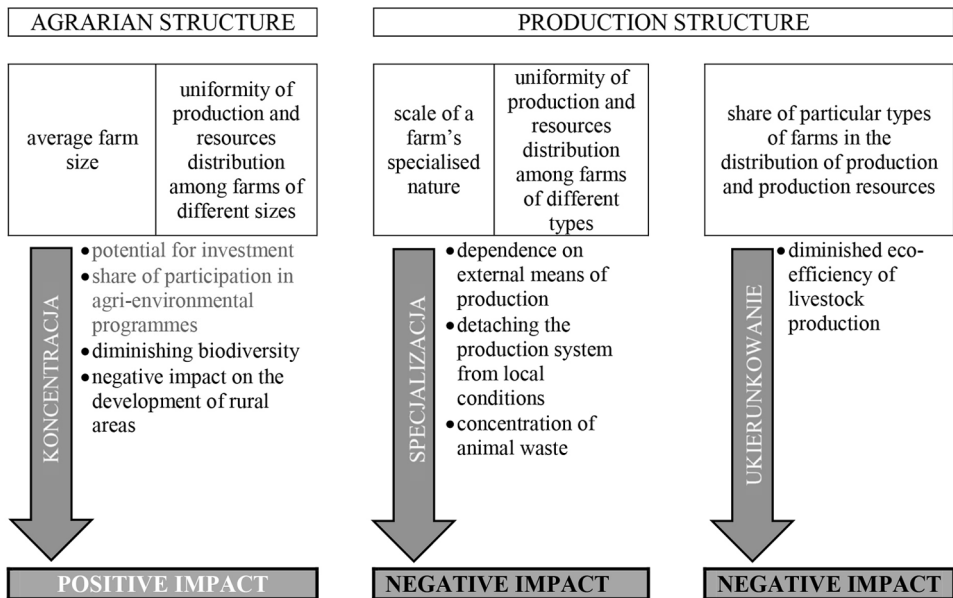
Figure 1. The impact of structures and structural change on economic efficiency of agriculture



Source: author's own development based on literature review.

Finally, consideration should be given to the possibilities of extending the stimulation of sustainable intensification. Relying on the new structural economy theory [Lin 2011], the question must be asked how much this process depends on the shape and changes within productive structures. The review of relevant literature (Fig. 1 and 2) has allowed to identify three dimensions of productive structures which can affect economic and environmental productivity of the agricultural sector.

Figure 2. The impact of structures and structural change on eco-efficiency of agriculture



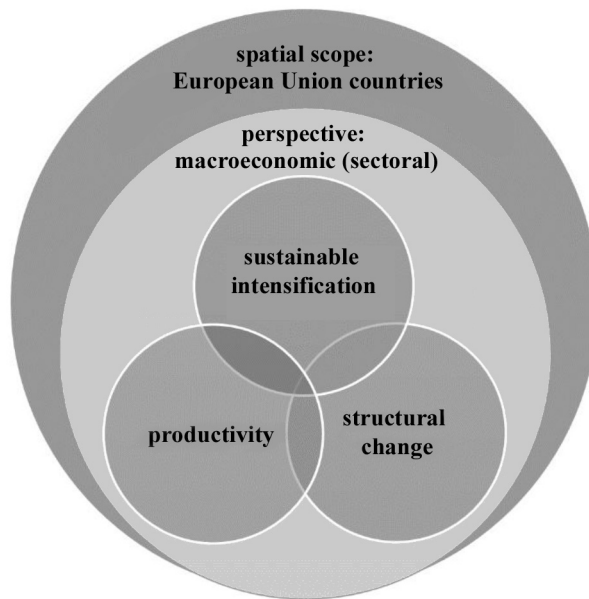
Source: author's own development based on literature review.

Finding an answer to the above questions can turn out to be particularly useful in the implementation of the Common Agricultural Policy (CAP) of the European Union. In a situation when the shape of this policy after 2020 is discussed, the conclusions of this dissertation can be especially helpful. Considering the fact that the postulates of sustainable intensification are in line with the objectives of CAP [Staniszewski 2017], the identified dependencies can be used as a theoretical basis for the construction of new policy tools exerting influence by means of structural changes. In the new perspective, the likelihood of implementing these changes is much higher, which is connected with the probable transfer of implementing the policy objectives to member countries which will have wider freedom in the implementation of the solutions adapted to the national specificity. The tools of structural policy can be also found among them.

Comparative studies into the structure of the agricultural sector in EU countries have been repeatedly discussed before [A. Czyżewski and Henisz-Matuszczak 2004, Pawlak and Poczta 2010, Babiak 2010, Majchrzak 2015, AKI 2016, Pope-

scu et al. 2016]. However, they focus mainly on the description of the shape and dynamics of the structure, disregarding the issue of the impact of these factors on production efficiency or merely indicating this influence without undertaking an empirical analysis. This study is complementary when compared to the previous ones as it makes use of detailed data concerning the shape of the structure for the purpose of quantitative analyses. Similar research [Vollrath 2007, Huffman and Evenson 2001, Bojnec et al. 2014, Nowak, Kijek and Domańska 2015] has been carried out so far mainly with regard to economic efficiency. The studies extending the analysis to the issues of generating the greatest value with the lowest possible ecological costs, that is eco-efficiency, have been conducted with a rather microeconomic approach [Wrzaszcz 2012, Gadanakis et al. 2014, Van Passel et al. 2007]. Thus, the proposed investigations fill the existing research gap (Fig. 3). They combine the concept of sustainable intensification with the analysis of total productivity and structural changes simultaneously comprising part of the trend of microeconomic (sectoral) evaluations and placing all the considerations in the context of the European Union.

Figure 3. The study situated within the framework of the present state of knowledge



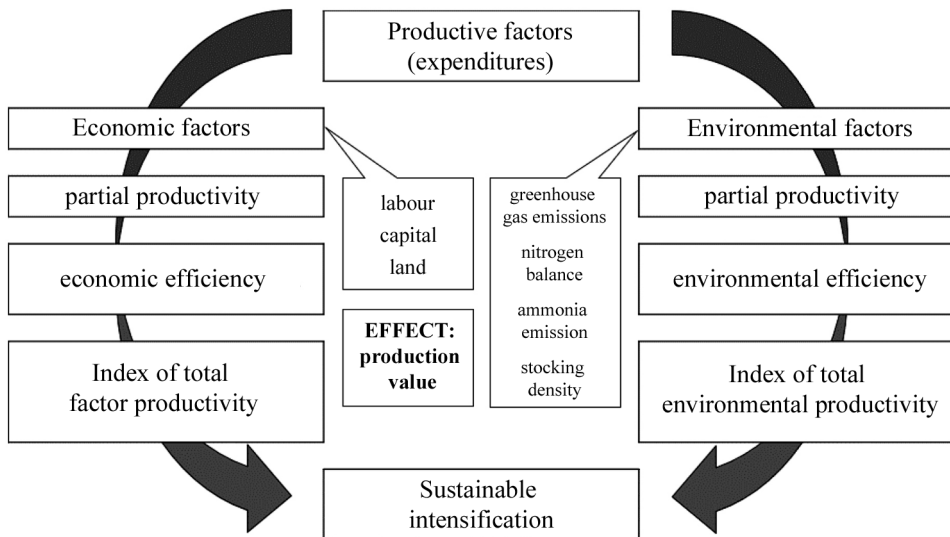
Source: author's own development.

2. BASIC CONCEPTS AND THEIR OPERATIONALISATION

The operationalisation of the concepts regarding sustainable intensification of agriculture and productive structures is one of the biggest challenges in the mentioned concept. The proposed approach to sustainable intensification regards

it as a simultaneous improvement of economic and environmental agricultural productivity or improvement in one of these areas without a negative impact on the results in the other area. The diagram of the research procedure is shown in Figure 4. Labour, capital and land are proposed in the studies as the elements of economic expenditure of production resources. On the other hand, the environmental expenditure includes greenhouse gas emissions, nitrogen balance, ammonia emission and stocking density. The aforementioned expenditures can be compared with production value which allows to determine partial productivity and subsequently the indicators of total efficiency, using the data envelopment analysis (DEA). Data for particular periods can then be used to specify dynamic indicators of total productivity, as defined by Malmquist. Comparing the values of these indicators for economic and environmental expenditures enables to define the synthetic indicator (SI) of sustainable intensification using analytical geometry, in particular, the measures of Euclidean and angle distance.

Figure 4. Operationalisation of the sustainable intensification concept



Source: author's own development.

Productive structures are a multidimensional term, therefore, the main problem of their operationalization is the limitation of the scope of the analysis. Relying on the correlations between the agricultural structure and productivity identified in the theory (Fig. 1 and 2) as well as considering the limitations of data availability, the analysis of productive structures can be limited to concentration, specialization and orientation with regard to the use of production resources and to production. The analytical scheme of the approach is shown in Table 1. The columns display the most often investigated, in the productivity context, dimensions of productive structures in agriculture. The lines indicate the production resources and production which allow to determine these dimensions in quantitative terms.

As far as concentration is concerned, one can talk about its measures in the form of average inputs of production resources and production as well as about the distribution of resources and production between farms of different economic sizes. As regards the analysis of distribution, the more resources and production are owned by the largest units the bigger concentration is. Specialisation can be discussed in absolute and relative terms.

Table 1. Productive structures in agriculture – analytical approach

Item		Dimensions of structure				
		concentration		specialisation		orientation
		average size	distribution	absolute	relative	(on plant/animal production)
productive factors	land	✓	✓	✓		
	labour	✓	✓	✓		
	livestock	✓	✓	✓		
production		✓	✓	✓	✓	✓

Source: author's own development.

In the first case, the evaluation covers the extent of concentrating the resources and production in one type of agricultural production. The relative approach determines deviations of production structure in a given country from the average structure in EU agriculture. Finally, through direction, it is assessed to what extent agriculture in a given country is specialised within a specific manufacturing direction.

3. OBJECTIVES, HYPOTHESES AND RESEARCH METHODS

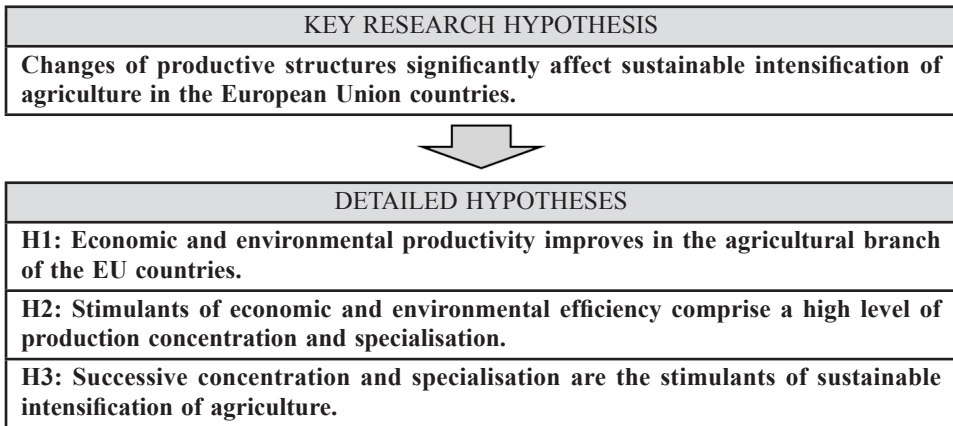
Determining the importance of structural determinants for the development of agricultural efficiency in economic and environmental terms as well as the impact of structural changes on sustainable intensification in the circumstances of the enlarged European Union can be assumed as the key objective of the proposed studies. Thus, formulated main objective is conducive to implementing the cognitive and application functions of the studies. It enables to enhance knowledge of agriculture behaviour as the branch of national economy in the aspect of the reasons for diversification in the efficiency of utilizing both economic and environmental resources and also allows to indicate the direction of new CAP tools. Numerous detailed objectives can be formulated to achieve the main goal:

- showing correlations between the studies and the theory of economy, especially the economy of sustainable development, agricultural economy, development economy and new structural economy;
- operationalisation of basic concepts such as sustainable agricultural intensification, economic efficiency, productive structures and structural change;

- identification, classification and measurement of determinants of economic and environmental productivity with regard to agriculture, based on the current achievements of economics in the field of theoretical and empirical studies;
- determining the condition and dynamics of productive structures of EU agriculture in terms of concentration, specialization and orientation of resources and production;
- defining structural determinants of agricultural efficiency in statistical terms;
- measuring sustainable intensification of agriculture in EU states in a dynamic approach and defining the determinants of this intensification.

Based on the review of relevant literature, the following hypotheses can be formulated (Fig. 5).

Figure 5. Research hypotheses



Source: author's own development.

A number of methods can be used to implement the proposed studies. First of all, it would be required to analyse relevant literature in the scope of such issues as the correlations between agriculture and economic development, structural change in economy, agricultural sector support, sustainable intensification of agriculture, measurement of productivity and efficiency as well as determinants of agricultural productivity and efficiency. Panel regression may comprise the key tool for empiric verification of hypotheses. It is possible to use cluster analysis, concentration indicators as well as specialization and similarity of structure in order to describe the shape and dynamics of productive structures, similarities and differences between EU countries in this respect. As regards determining the efficiency of the agricultural branch in EU countries, it is possible to apply the data envelopment analysis (DEA) and with regard to defining the dynamics of total factor productivity (TFP), the Malmquist index (MI) can be used.

The studies can be carried out using secondary data from Eurostat resources, specifically, data of the Economic Accounts for Agriculture (EAA), agri-environmental indicators and the Farm Structure Survey.

The Eurostat data base is the best source of harmonized statistical information on agriculture of all European Union member states. These data allow to analyse the figures of the years 2005-2013. Statistical and econometric packages including DEAP 2.1, Gretl 2016d and Statistica 12 can be used for calculations.

4. RESEARCH STRUCTURE

The research can be divided into six stages within which particular detailed objectives of the study will be achieved (Fig. 6). First of all, the context of the research should be presented, namely, the role played so far by agriculture in the economic development of the countries, especially within the theory of structural transformations and development economics. Yet, some aspects should be added to this traditional approach, specifically, the application in the agricultural branch context concerning the assumptions of new structural economy as well as the sustainable development theory. These considerations can be extended with the description of the evolution of the approach to the development and support of the agricultural sector, towards the balancing of production methods and the payment for provided public goods. As a tool for the operationalization of theoretical considerations on sustainable development there should be also presented the concept of sustainable intensification, that is, it is required to discuss the definitions of this term and current strategies of quantitative studies carried out in this field as well as the specific approach to this problem connected with the EU context of the research. Second of all, it is proposed to consider definition issues concerning the measurement of sustainable intensification and its structural determinants. Different methods of defining and estimating the efficiency should be introduced and current studies conducted in this area should be presented. Based on the above information, it is possible to display the method of estimating the dynamics of sustainable intensification. As far as productive structures are concerned, the main role is to indicate their volume which is essential for the effectiveness of agricultural production. The third stage suggests identifying the wide range of determinants of economic efficiency and eco-efficiency of agricultural operations and studies into their empirical verification. In the face of the substantial set of these variables, it seems necessary to systematize them.

Figure 6. Ideograph of studies

Placement of the studies in the theory of economics		
The role of the agricultural branch in development	Paradigm of sustainable development	Structures and structural changes vs economic development
Evolution of agricultural policy tools to fees for non-agricultural functions of agriculture		
Placement of studies within the realities of the European Union		
Usability of the concept of sustainable agricultural intensification		

Establishing basic labour terms and their operationalization		
<i>Sustainable intensification (SI) of agriculture</i>	<i>Economic efficiency</i>	<i>Productive structures and structural change</i>
Unification of the definition of SI in the context of the European Union	Efficiency and related terms in the theory of economics	Structural variables as factors and measures
Review of methods and objectives of SI research	Review of efficiency and productivity measurement methods	Impact of structural factors on agricultural productivity
Total economic and environmental productivity of agriculture		Concentration, specialisation and orientation of agriculture

Identification, classification and measurement of economic and environmental productivity determinants of agriculture		
<i>Endogenic determinants</i>	<i>Exogenic determinants</i>	<i>Institutional determinants</i>
technology	infrastructure	connection with market
human resources	natural surrounding	ownership of productive resources
	macroeconomic surrounding	agricultural policy
Determining the measures for other determinants of agricultural production efficiency		

Determining the condition and dynamics of productive structures of EU agriculture		
<i>production concentration</i>	<i>production specialisation</i>	<i>orientation</i>
Average value and distribution concerning the factors of labour, land, livestock and production regarding farms of various sizes	The distribution of labour, land, livestock and production factors between different production types of farms, the share of mixed and self-supply production	The share of livestock production
Identification of structural genotypes of agriculture		
Determining the pace and direction of structural changes in agriculture		

Determining the structural determinants of agricultural efficiency in terms of static approach – empirical verification H2		
Choice of methods regarding modelling of panel data		
Measurement of economic efficiency of agriculture	Measurement of agricultural eco-efficiency	
Choice of explanatory variables	Construction of the model	Testing the resistance of the model
Identification of key structural determinants of economic efficiency and eco-efficiency of agriculture		

Measurement of sustainable intensification of agriculture in UE countries and establishing its determinants – empirical verification H1, H3	
Measurement of dynamics of total economic productivity concerning agriculture	Measurement of dynamics of total environmental productivity concerning agriculture
Establishing optimal and real paths of sustainable intensification and their comparison	
Calculation of the synthetic indicator of sustainable intensification	
Construction of the model	Testing the resistance of the model
Developing the sustainable intensification strategy for agriculture in the EU states	

Source: author's own development.

For the empirical verification of the indicated hypotheses, appropriate measures should be pointed. The fourth stage includes a comprehensive review of productive structures of agriculture in the EU countries considering the similarities and differences between them and the dynamics of structural changes. The fifth and sixth stage includes the verification of research hypotheses.

5. SUMMARY

This paper presents justification for the studies on sustainable intensification of agricultural production in the EU countries as well as the concept of such studies including the investigation of structural determinants of this process. Among the main arguments supporting this direction of research, one may point the need to improve the agricultural eco-efficiency in the EU as well as little interest of researchers in analysing sustainable intensification at the level of agricultural sector. Nevertheless, when referring to application advantages of this type of research, one can mention their links with CAP and ensuing potential recommendations, specifically in the context of structural policy. The biggest research challenges concerning the proposed studies include the measurement of sustainable intensification at the level of agricultural sector, the limitation of a wide range of productive agricultural structures and the identification of the set of determinants other than the structural ones regarding this process. Additionally, the study displays proposed methods of solving these issues. The use of efficiency and productivity measurement tools such as DEA and Malmquist TFP indicators has been proposed in order to measure sustainable intensification. Based on the review of relevant literature, it has been also proposed to reduce the set of the structural variables included in the research to the measures of concentration, specialization and orientation, whereas other control variables have been grouped into endogenous, exogenous and institutional variables.

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KONCEPCJA BADAŃ STRUKTURALNYCH DETERMINANT ZRÓWNOWAŻONEJ INTENSYFIKACJI ROLNICTWA W KRAJACH UNII EUROPEJSKIEJ

Streszczenie: Celem pracy jest przybliżenie problematyki badań zrównoważonej intensyfikacji rolnictwa w specyficznym kontekście Unii Europejskiej oraz zaprezentowanie koncepcji takich badań. Opierają się one o zastosowanie względem danych z zasobów Eurostat metod szacowania efektywności (DEA) i produktywności (indeks TFP Malmquista) dla określenia wskaźnika zrównoważonej intensyfikacji, a także zidentyfikowanie za pomocą regresji panelowej strukturalnych determinant tego procesu. Na podstawie dokonanego przeglądu literatury, badania ograniczyć można do testowania oddziaływania koncentracji, specjalizacji i ukierunkowania produkcji rolnej. Jako zmienne kontrolne, w badaniu umieścić zaś należy te opisujące uwarunkowania endogeniczne, egzogeniczne i instytucjonalne.

Słowa kluczowe: zrównoważona intensyfikacja, efektywność, zmiana strukturalna.

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