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Sustainable economic development assessment model for family farms

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Abstract: This article is aimed to address the issue of sustainable economic development assessment in family farms. A complex methodology of family farm sustainable economic development assessment based on the family farm sustainable economic development index has been created following analysis of family farm sustainable economic development assessment methodologies, which are proposed by scientists and used in practice. The Kruskal-Wallis test and hierarchical cluster analysis were used to check the relevance of the index in family farm sustainable economic development assessment. The index value range was calculated using descriptive statistics. The characteristics of the index allow creating models for family farm sustainable economic development classification types based on *k*-means clustering. The family farms were classified into nine types. Examples of Lithuanian family farms were provided to demonstrate practical applications of the index. Furthermore, analysis of Lithuanian family farm sustainable economic development types by specialisation enabled to identify the main reasons for the existing situation in the farms.

Keywords: family farms, family farm sustainable economic development index, sustainable economic development

In accordance with the generally accepted sustainable development approach, scientists admit that consistent and sustainable agricultural development is determined by three major factors: economic (profitable production), environmental (sustainable environment), and social (thriving rural society).

Both globally and in the European Union (EU), family farms are by far the biggest group of food producers. Trends of sustainable development of agriculture are directly related to the prospects of such farm business. Therefore, in order to anticipate the development trends, it is essential to evaluate the economic, social and environmental sustainability of such farms.

An analysis of the scientific literature on the assessment of sustainable agriculture showed that the scientists mostly research environmental and social sustainability in agriculture, while the economic factor is neglected as something natural, which is based on the common methodologies of economic sustainability assessment. However, previous investigations by the authors found that, due to the nature of the family farm activities as well as different economic indicators that are used in assessment and issues of their comparison, the used methodologies for family farm sustainable economic development assessment are not fully relevant to the evaluation of sustainable economic development trends and identification of prospects for future activities in agriculture and family farms in particular. Different interpretations of the conceptions of sustainable economic development of family farms and sustainability concepts and emphasis on diverse priorities lead to varied views on the assessment of sustainable economic development of farms and explain the use of diversified indicators and methodologies to measure family farm sustainable economic development, whereas the evaluation objectives involve individually chosen methods and assumptions. The characteristic features of family farms, such as their organisational structure, the specificity of the farm work of the farmer, partners, and family members, the peculiarities of financial contributions and withdrawals, also reaffirm the need for family farm sustainable economic development assessment methodology. Thus the scientific problem addressed in this research is: what indicators and methods should be used in the complex assessment of the sustainable economic development of family farms.

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Subject of research: the assessment of the sustainable economic development of family farms

Research aim: the proposal of the complex methodology of sustainable economic development assessment in family farms following analysis of family farm sustainable economic development assessment methodologies, which were proposed by scientists and used in practice; and the creation of the methodology empirically tested on the example of Lithuania.

The above-mentioned aim was accomplished by fulfilling the following *research objectives*:

– to define the characteristics of family farm sustainable economic development in the context of the research;

– to identify limitations of family farm sustainable economic development assessment methodologies used in previous investigations;

– to produce a family farm sustainable economic development index and to justify its suitability for the assessment of the sustainable economic development of a farm.

RESEARCH METHODS

The methods used to investigate the research problem include the analysis and synthesis of scientific literature, deduction, induction, and other general research methods. The family farm sustainable economic development index was produced on the basis of previous scientific research, operationalisation, content validation, and descriptive statistics. The research used data from Lithuanian family farms' reports for 2013–2015.

Characteristics of family farm sustainable economic development

The scientists have always seen sustainability as a permanent objective pursued in farming practice that is based on the use of renewable natural resources only with respect of life cycles, the biodiversity that is essential for the functioning of ecosystems, the polluter pays principle, and guaranteed energy balance, having regard to the interpretations of the concept of sustainable agriculture (Francis et al. 2003; Pimentel et al. 2005). Gomiero et al. (2011) argue that sustainable agriculture should aim at preserving natural resources, especially soil and water, relying on minimum artificial inputs from outside the farm system; it should be able to recover from the disturbances caused by cultivation and harvest while at the same time being economically and socially viable. The interpretations of the concept of sustainable agriculture were summarised in Pretty (2008) and Zimdahl (2012). Vitunskienė and Vinciūnienė (2014) maintain that sustainable agriculture focuses on farmer's economic profitability, preserves and improves the environment and contributes to the well-being of farmers and rural communities. The main objective of sustainability is to combine the economic, social and environmental dimensions and to take into account the possibility of continuity over time.

According to UNEP (2010), individual human communities should agree and decide how to achieve global agricultural sustainability. The objectives while addressing problems on different levels differ depending on the timing, public attitudes, internationally agreed goals. Long (2012) notes that the definition of sustainable agriculture proposed by The United States Department of Agriculture (USDA 1990), which says that "sustainable agriculture, over the long term, will: (i) satisfy human food and fibre needs; (ii) enhance environmental quality and the natural resource base upon which the agricultural economy depends on; (iii) make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; (iv) sustain the economic viability of farm operations; and (v) enhance the quality of life for farmers and society as a whole", is most commonly used and established. The definitions of sustainable agriculture manifest the key aspects of sustainability and their applicability in agriculture.

Sustainable agriculture means a system that over the long term will enhance environmental quality and the natural resource base upon which the agricultural economy depends, satisfy human food and fibre needs, sustain economic viability, and enhance the quality of life for farmers and society as a whole (ASA 1989).

Analysis of scientific literature (Gafsi et al. 2006; Gliessman 2007; Vitunskienė and Vinciūnienė 2014) on sustainable development of agriculture seems to suggest that, first, the economic factor of sustainability is the key factor in agricultural sustainability as the efficiency of the other two factors is dependent thereon. The financial gain obtained by farmers from their agricultural activities should be sufficient to sustain viability, encourage production, conserve

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and protect the environment, and contribute to the enhancement of the quality of life for the local society. This enables the use of a holistic approach in the assessment of family farm sustainable economic development.

Second, the element of complexity, which includes indicators describing the condition and prospects of farms, is essential in the assessment of family farm economic sustainability.

Justification of indicators of family farm sustainable economic development assessment and index testing methodology

The finding to emerge from the analysis of the scientific literature and the results of empirical research of sustainable economic development assessment in family farms is that there is no complex methodology of sustainable economic development assessment for systematic evaluation of family farm economic sustainability, which would allow appropriate management decisions to be made that are geared to sustainable agriculture (Tisdell 1996; Argiles 2001; Koleda and Lace 2010; Wu and Wu 2012).

The main focus of this research is the creation of the methodology for designing a complex indicator for assessment of the sustainable economic development of family farms that will allow farms to be grouped by economic sustainability levels (weak, moderate or strong). According to Scotti et al. (2011), a complex indicator for assessment of farm sustainability should be designed with regard to the selection criteria of the indicators it comprises. Scotti et al. (2011) highlighted that attention must be paid to the sustainability indicator selection principles, such as clear goals, sustainability assessment elements, issues related to the assessment process and follow-up, conservation and development.

The design of the complex indicator of family farm sustainable economic development assessment takes into consideration the results of scientific research by Koleda and Lace (2009) and Koleda and Lace (2010). These authors carried out a detailed analysis of indicator variables and combined them to create complex indicators in order to reduce the number of indicators and to facilitate decision-making (Table 1).

Essentially four dominant variables of farm sustainable economic development indicators can be distinguished: total output (at basic prices), costs/expenses, assets, and liabilities (Table 1). Other indicator variables reflect the constituents of the main variables (current debts, current assets, depreciation, intermediate consumption).

In the light of the analysis of family farm economic sustainability indicators used by scientists and the development of a complex indicator of family farm sustainable economic development, the indicator is proposed to consist of indicator variables that are most commonly used in scientific research and that fully describe the levels of family farm sustainable economic development (weak, moderate or strong), where each variable is assigned respective characteristics in that area, i.e. the deduction method is used.

The arguments that were used in the variable selection process are described below.

Table 1. Indicator variables in family farm sustainable economic development assessment and calculation methodology

Indicators	Indicator variables
Return on equity	farm net income; equity
Return on assets	farm net income; assets at the end of the year
Operating expense ratio	expense; total output at basic prices
Current ratio	current farm assets; current debt
Debt to assets	liability; assets
Gross margin	gross value added; total output at basic prices
Asset turnover ratio	total output at basic prices; assets
Labour productivity	farm net income; annual work unit (AWU)
Land productivity	farm net income; hectare of utilisable agricultural area (UAA)
Debt to total output ratio	liability; total output at basic prices
Depreciation expense ratio	depreciation; total output at basic prices

Source: own processing

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Scotti et al. (2011) contend that the sustainability concept can be used to assess family farm sustainable economic development. At the weak level of sustainable economic development, the indicator of liabilities is of significant importance as it reflects the farm's ability to meet liabilities and to find sources to cover accumulated losses. According to Argiles (2001), heavily indebted farms employ different strategies that lead to a decrease of the total output in the future and thus boost the financial burden of the farm and decrease the prospects of farm sustainability. Therefore, the liability indicator is highly important in measuring the weak level of sustainable economic development.

Van der Meulen et al. (2014) maintain that deterioration of the financial situation can hardly be avoided in the modern business environment if the farm belongs to the group of a moderate level of sustainable economic development. Consequently, the development of farm activity highly depends on the size of the assets owned by the farmers, which reflects the level of solvency, the farm's ability to meet liabilities from its own resources, the financial risk, the risk of unviability. Bossel (2001) points out that farms at the level of moderate sustainable economic development have to be in a position to protect themselves against harmful environmental challenges, i.e. changing, varying and unpredictable conditions diverging from the usual.

Morehart (2000) and Wu and Wu (2012) argue that a strong level of family farm economic sustainability is demonstrated by the farmer's ability to combine the capital, labour, and natural resources in organising agricultural activities, implementing innovations, making a profit and putting their assets at risk. According to Tisdell (1996), a strong level of economic sustainability is represented by the total value of output to the total value of input ratio, which is understood as a positive result of farm operations over a certain period. Scott (2001) and Scott and Colman (2008) claim that the level of sustainability in the agricultural sector can be measured with reference to the net revenue and the cost/income ratio. Morehard (2000) maintains that it is reflected by the difference between the income from the products and production costs (part thereof).

The components of the complex indicator are indicative of the levels of the farm economic sustainability development where the weak, moderate or strong levels are, respectively, supported by the indicators of liabilities, solvency, and profitability.

The researchers most commonly focus on the indicator of liabilities. The previous research has been concerned with farm unviability issues rather than the potential sustainability perspectives (Scott 2001; Singh et al. 2009). The farm perspectives are reflected by the assets owned by the farm. The assets of a family farm can be mortgaged/pledged or not. The pledged/mortgaged assets should ensure the economic growth of the farm, while the share of unpledged/unmortgaged assets demonstrates the farm's ability to borrow and create added value to satisfy its needs. The farm's total value of the output to the total value of the input ratio is relevant for all farm levels, and it indicates the state resulting from the operational activities of the farm (Tisdell 1996). Consequently, the selected components play an important role in analysing farm sustainable economic development by levels. Tisdell (1996) termed the indicator of economic efficiency (EE) the sustainability indicator.

Although Tisdell (1996) offers a formula of the total value of output to the total value of the input ratio and defines the result as sustainability, no verification arguments regarding this result, like sustainability, have been found either in his or other authors' works. That does not mean that the total value of the output to the total value of the input ratio as a sustainability indicator is called into question essentially. What is actually questioned is the contextual relevance of the sustainability to this research into farm sustainable economic development assessment. Therefore, the operationalisation method-based sustainability indicator used by Tisdell (1996) represents an additional variable of assets and liabilities, which reflects a long-term perspective of a farm. The index of family farm sustainable economic development (I_{FSED}) is based on both indicators (Equation 1).

$$I_{FSED} = \frac{TO_{BP} + A_{CURR} + A_{FIXED}}{INT_{CONS} + D + EXT_{FAC} + UNP_{LAB} + D_{CURR} + D_{FIXED}} \quad (1)$$

where:

TO_{BP} – total output (at basic prices);

A_{CURR} – current farm assets;

A_{FIXED} – fixed farm assets;

INT_{CONS} – intermediate consumption;

D – depreciation;

EXT_{FAC} – external factors;

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UNP_{LAB} – unpaid labour (farmer and family members);
D_{CURR} – current debt;
D_{FIXED} – fixed debt.

The family farm sustainable economic development index can be used to rate weak, moderate or strong sustainable economic development farms within the established thresholds (Table 1). The produced sustainable economic development index (I_{FSED}) shows to which type of the sustainable economic development a farm belongs.

The family farm sustainable economic development index will help to determine the type of farm economic sustainability (weak, moderate or strong) and the farm's potential of growth and development, including its ability to have stable growth based on the existing resources. The interpretation of the family farm sustainable economic development index depends on the aims of the assessment. The objective of this assessment is to provide information regarding the current level and perspectives of family farm sustainable economic development. The created indicator is highly practical for making management decisions and observing trends in making comparisons of different farms (in terms of farm specialisation, size). The family farm sustainable economic development index facilitates communication between the family farms and the general public and promotes accountability; it is easier to interpret than a set of indicators; it can be used to measure the progress of farms and agricultural systems during the period in question.

The mathematical methods are used to test the theoretical family farm sustainable economic development index. That aims at verifying the ability of the family farm sustainable economic development index and its component (economic efficiency of a farm) – to express their theoretical characteristics mathematically and establish it as a new index of family farm sustainable economic development.

DESCRIPTION OF TESTING PROCESS

Since the family farm sustainable economic development index has an integrated component (a farm economic efficiency coefficient), the testing is performed on two levels. The first level involves calculation of the initial family farm economic efficiency coefficient, which is integrated in the family farm sustainable economic development index. The second level deals with the calculation of the family farm sustainable economic development index. That is appropriate because both the integrated farm economic efficiency coefficient and the complex family farm sustainable economic development index, which the coefficient is integrated into, are theoretically informative and capable of providing important information regarding the economic efficiency of a family farm, reflecting the relationship between the farm's total value of output to total value of input ratio and the farm sustainable economic development index, which performs a correction function by adjusting the farm economic efficiency coefficient by means of the assessment of the farm state from the perspective of the farm assets and liabilities. Introduction of this perspective gave a theoretical possibility to set the state resulting from the operational activities of a farm apart from its ability to survive and develop, which is expressed as a complex family farm sustainable economic development index.

The methodology of family farm sustainable economic development index testing consists of four logical constructs: content validation of the family farm sustainable economic development index, methods of descriptive statistics, examination of the typological model of the family farm sustainable economic development index characteristics in Lithuanian farms, and the methodology of assessment of Lithuanian family farm characteristics and family farm assignment to a sustainable economic development type. The testing process is summarised in Table 2.

Data on the Lithuanian farms have been used for empirical verification of the model for assessment of the sustainability of farm economic viability. Data for the research were conducted on the level of farmers' farms and have been drawn from the list of farmers' farms-respondents included into the Farm Accountancy Data Network (FADN) using the information of the Lithuanian Agricultural Advisory Service. These farms are typical Lithuanian farms and reflect the characteristics of all Lithuanian farms. All the farms manage the farm accountancy and submit information about their productive and financial activities. Farmers' farms-respondents cover all municipalities of the country, different natural zones and reflect various farming conditions.

For verification of farm sample representativeness, the formula by Malhotra (2007) has been employed in the calculation of the random sample. The calculation of random sample indicator has shown that data of 3 917 farms-respondents need to be used to achieve

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Table 2. Family farm sustainable economic development index (I_{FSED}) testing stages

Stage: objective	Result
Stage 1*: justification of the defined content of the I_{FSED}	*Kruskal-Wallis test* was used to identify the FSED sensitivity scale; there is a difference between the FSED levels (weak, moderate, strong); the levels supply the adequate sensitivity required to identify family farm differences according to the aforesaid sustainable economic development levels *hierarchical cluster analysis* was used to measure the classification capacity of FSED; the development profile patterns of farms attributed to the weak, moderate and strong sustainable economic development levels do not differ, the only difference being the sustainable economic development level *linear diagrams* were used to visualise the identified clusters over a period; the linear diagrams show the types of established clusters (five types); that highlights the classification capacity of the FSED, which is essential for characterisation of the index ability to measure the intensity (high/low) and type (stable/growing) of the measured characteristic, either taken separately or jointly (high, growing)
Stage 2: identification of I_{FSED} range and economic efficiency thresholds	standardisation equation was used to calculate the thresholds of the indicators
Stage 3: identification of family farm classification types	models for family farm sustainable economic development classification were created using the *k*-means clustering (farm types 1–9)
Stage 4: empiric research	analysis of family farm sustainable economic development types by specialisation; identification of the main reasons for the existing situation in the farms

*the performed content validation of the I_{FSED} established that the I_{FSED} measures sustainability, the content validation was performed using three different complementary methods, which explained different aspects of the same phenomenon; FSED – family farm sustainable economic development

Source: own processing

95% of reliability. The farms of different sizes and farming types have been sampled proportionately for the research. The farms engaged in crop production, livestock production, mixed farming, horticulture and/or gardening, and other agricultural activities (beekeeping, rabbit farming, paultry farming) have been used for the research.

The *k*-means clustering method was used to assess the discriminatory capacity of family farm sustainable economic development and economic efficiency. It was chosen for its ability to reconstruct the classification structure of a phenomenon and to answer the question what types are specific to this phenomenon. This method is suitable for classification of continuous variables in large research samples. Therefore the research sample and the family farm sustainable economic development index and economic efficiency coefficient meet the research method requirements.

The classification used the maximum permissible number of clusters for the family farm sustainable economic development index and the economic efficiency coefficient variables and thus the theoretical number of cluster patterns could be easily worked out. As a result nine theoretically possible clusters were developed. Farm classification revealed that a sample of 3 917 farms included all nine types. The largest number of farms was in the cluster with moderate family farm sustainable economic development and average economic efficiency (total number = 2 590), and the smallest number of farms was in the cluster with weak family farm sustainable economic development and low economic efficiency (total number = 5). Figure 1 illustrates the classification data.

The majority of farms that attributed to the moderate, sustainable economic development type have an average economic efficiency level. This is quite logical, as given that the sample size is relatively large, theoretically, the distribution of farm types should show a tendency toward a normal distribution. Certainly, this should not be required from a selected sample, but such result nevertheless suggests that the existence of outliers in both rejection regions shows that most of the analysed farm population fall within farms that can be ranked as average both from the

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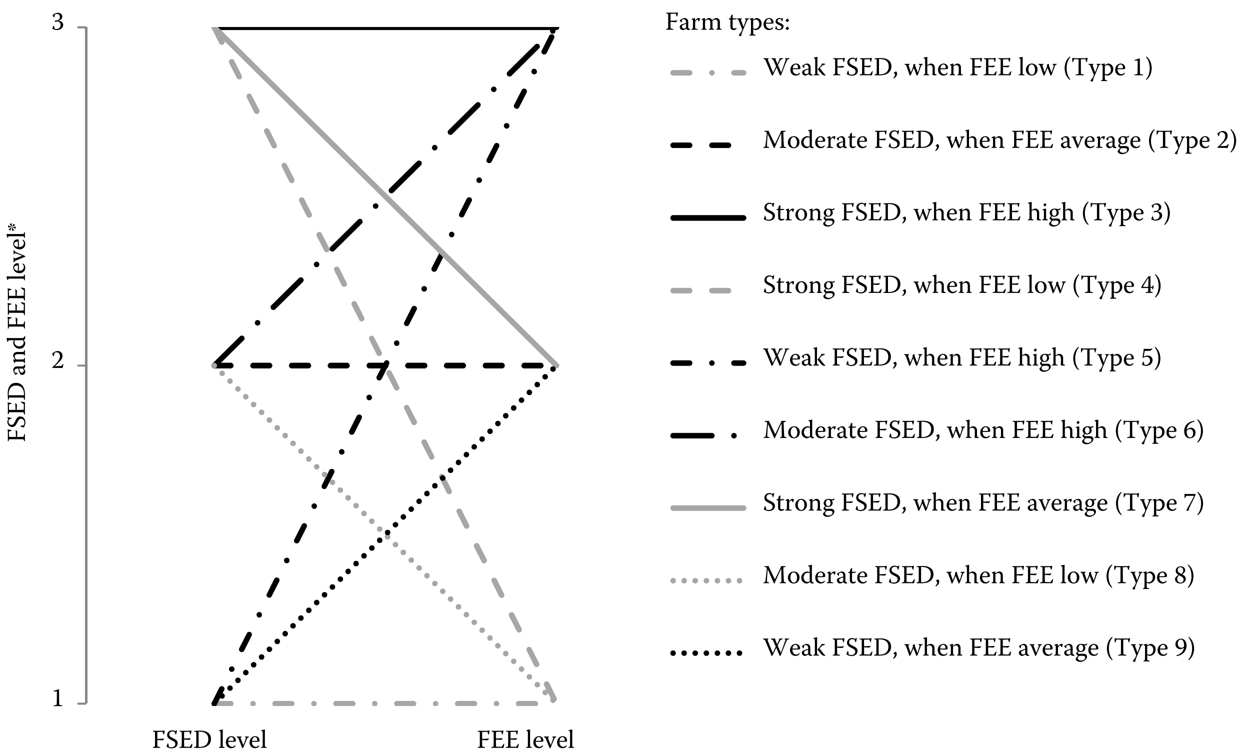

Figure 1. Typological model of family farm sustainable economic development (FSED) and farm economic efficiency (FEE), number = 3 917

*FSED and FEE levels: level 1 – weak FSED, low FEE; level 2 – moderate FSED, average FEE; level 3 – strong FSED, high FEE

Source: own processing

logical and mathematical perspective. From modelling, which resulted in creating the family farm sustainable economic development index with the integrated farm economic efficiency coefficient, to the empiric research, where analysis of the sample revealed that the research result is consistent with the assessment logic, the investigation can be considered successful.

CONCLUSION

In the research context, the definition of the characteristics of the sustainable economic revealed that the economic factor of sustainability is the key factor in agricultural sustainability as the efficiency of the other two factors (environmental and social) is dependent thereon. The financial gain obtained by farmers from their agricultural activities should be sufficient to sustain viability, encourage production, conserve and protect the environment, and contribute to the enhancement of the quality of life for the local society. This enables the use of the holistic approach in the assessment of the family farm sustainable economic development.

The element of complexity, which includes the indicators describing the condition and prospects of farms, is essential in the assessment of family farm economic sustainability.

After limitations of family farm sustainable economic development assessment methodologies used in previous investigations were identified, it was found that the assessment of sustainable economic development uses several indicators which directly or indirectly provide information about the future viability, identify levels of social objectives, such as material welfare or environmental quality, although it does not provide information regarding the current level and perspectives of family farm sustainable economic development. There is no complex methodology of sustainable economic development assessment for systematic evaluation of family farm economic sustainability, which would allow appropri-

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ate management decisions geared towards sustainable agriculture.

The produced family farm sustainable economic development index and justification of its suitability for the assessment of the sustainable economic development of a farm resulted in the following:

– indicators that are most commonly used in scientific literature to assess farm sustainable economic development were determined, and analysis of the assessment of family farm sustainability indicator variables was performed;

– the selected variables of the indicators (costs/expenses, assets, and liabilities) were used to develop the family farm sustainable economic development index, and the use of the sustainable economic development indicator variables in creating the family farm sustainable economic development index was justified;

– the index characteristics help to determine the type of farm economic sustainability (weak, moderate or strong) and the farm‘s potential of growth and development, including its ability to have stable growth based on the existing resources;

– the methodology of family farm sustainable economic development index testing consists of four logical constructs: content validation of the family farm sustainable economic development index, methods of descriptive statistics, examination of the typological model of the family farm sustainable economic development index characteristics in Lithuanian farms, and the methodology of assessment of Lithuanian family farm characteristics including assignment to a family farm sustainable economic development type.

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