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APPROACES TO SELECTION AND INTEGRATION OF INDICATORS FOR SUSTAINABLE DEVELOPMENT OF AGRICULTURE

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ABSTRACT
The sustainable development of agriculture is a complex issue, combining a large number of interdependent factors, processes and institutions. People involved in the sector need convenient and suitable instruments to assess and evaluate the sustainability of their farming systems in order to improve their economic performance and environmental and social commitment. The concept of sustainable development, even though popular during the last 20-30 years, is not clear from theoretical and methodological points of view. Agriculture with its characteristics places additional challenges, when it needs to be evaluated.
The objectives of this study are to define agricultural sustainability, and also to develop particular methodology and instruments for measuring and analyses of the state and the dynamics of milk production in all relevant aspects – economic, social and environmental. To meet the challenges of evaluating sustainable development on farm level, an integrated approach for monitoring, modeling and assessment is needed for any individual farm. As a result of the survey, a tool was created that allows indicators to be integrated into indices, which can be adapted to different situations, yet remain simple and understandable.

Key words: multi-attribute utility, integration, function of sustainability

MATERIALS AND METHODS

Sustainability function of dairy farming

Measuring sustainable development needs an integrated approach which takes into account all aspects of farming activities (1). Many organizations have developed their own instruments for sustainability evaluation, like the Organization for Economic Cooperation and Development, the World Bank, European Union, United Nations, Food and Agriculture Organization. Methods for evaluation of interactivity between the various economic, environmental, demographic and social parameters of a sectors development are not well established at the moment. Therefore, sustainability indicators should be created, to meet the needs for a solid basis for decision making and policy measures at all levels (2). Careful selection and application of sustainability indicators is a first step towards establishing a comprehensive and complete picture. There are many approaches to the creation of tools for management and for analysis of different indicators. Each of them seeks the most appropriate processes or issues in the specific circumstances that are often in conflict among themselves. One goal however remains up to date: how to present a variety of diverse information within a common framework (3). Often, when it is used a framework, based on indicators, it takes the shape of the so called "Three pillar concept". The pillars are economic, social and environmental. Very popular is the „Pressure-State-Response" framework, developed by OECD **(fig.1)**.

Despite the increased interest in assessing the agricultural sustainability, there are no convenient methods at production level, that objectively determine the status of farming systems in the different aspects of sustainable development. According to Rigby et al (2001), the creation of attributes for sustainable

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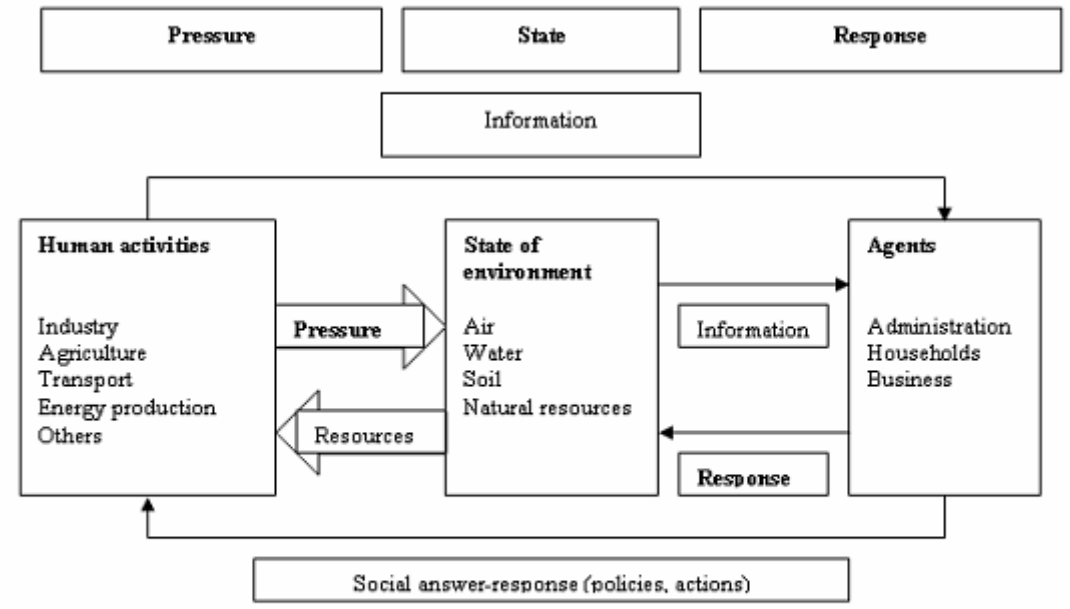
development of agriculture, could be an efficient way to make the concept operational (4).

When selecting the indicators to the specific area of agricultural sustainability, evaluators must respect the criterion of OECD for indicators: to be appropriate, relevant, measurable, analytically sound (5). The integration of various indicators into a common function of sustainable development is a difficult and complex problem. The formulation of a common sustainability function requires that all indicators in the framework are measured in comparable units.



Pressure - State - Response Framework
Source: OECD, 1993

Fig. 1

A comprehensive sustainability evaluation of farms, based on multiple parameters (attributes) can be done by „multi-attribute utility models" (6). With the „Multi-Attribute Utility Theory" (MAUT), a common utility function can be created, which integrates the utility functions of all individual attributes (7).

$$Uj\ (x1, x2, \ldots xn) = \Sigma wi\ ui(xi)$$
$$j = (1,2,3);\ i = (1.....n);\ wi \geq 0;\ \Sigma wi = 1$$

Where Uj is the multi-attribute utility function for the j-th aspect of sustainable development (economic, social or environmental), ui(xi) is the utility of i-th attribute , and wi is the weight of i-th attribute.

Then the sustainability function (S) is presented as:

$$S(U1,U2,U3) = \Sigma WjUj \qquad j = 1.....3$$

Where Wj is the weight of *j*-th aspect of sustainability

$$(Wj \geq 0, \Sigma Wj = 1)$$

In this study, the theory of multi-attribute utility is used to create a function (index) for sustainable development of dairy farms in Bulgaria. This approach consists of five basic steps: "Step 1" is associated with the determination of the values of all items selected for analyses of sustainability of specific farm. "Step 2" integrates the values of indicators in various aspects of sustainability: economic, social and environmental. In "Step 3" the values of the three aspects are summed up in a common sustainability function of the specific farm. Since farms are diverse in size, they need to be differentiated into several more homogeneous groups. "Step 4" determines the sustainability of each group of farms. "Step 5" defines the whole sector's sustainable development by integrating the values of all groups of holdings into one overall sustainability index.

There are two approaches in defining and measuring agricultural sustainability. The first one is based on the selection of indicators that are locally specific and can change according

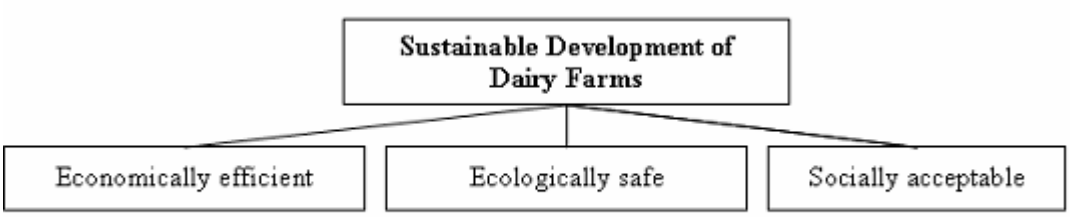
to the prevailing situation on the farm. In some cases a particular indicator is used on a specific farm but in other farms where there is no need for such measurements – this indicator will not be included in the function. The other approach is based on the measurement principles of sustainability to be the same, regardless of the specifics in the individual farms. It is obvious that both approaches have advantages and disadvantages. The locally specific approach avoids the inconvenience to seek a universal set of indicators, which is often subjective. The weakness of this approach is the strength of the second one, namely the need to compare and contrast different farms. The second approach allows such comparison because in all cases it uses one same set of indicators, measured in the same units (8).

Developing indexes, by integrating individual indicators

When calculating farm's sustainability, very often in the equation have to be integrated qualitative and quantitative indicators. On the other hand, even in the group of quantitative indicators only, it is not possible directly summing up their values in a common index, because they are measured in different units. It is necessary to convert all indicators to a common scale first, and then to integrate them into the sustainability index. Frequently a simple scale is applied, such as percentage (0 – 100 %) or 0 – 10, or 0 – 1. An important point of this approach is the determination of the minimum and the maximum levels for each indicator, corresponding to 0 and 10, or 0 and 1. The better the state of the farm on a given parameter, the higher the score (closer to 10) and vice versa, if the situation on certain indicator is unsatisfactory the score is falling (approaches 0).

Indicators for sustainable development of dairy farms

In order to achieve an objective assessment of the various aspects of dairy farm's sustainability a comprehensive and coherent approach is required which is based on three elements: economic, social and environmental (9).



Dimensions of sustainability of dairy farms

Fig. 2

Dairy farming is a production process as well as a way of life, which has positive and in the same time negative environmental effects. This requires, when evaluating its sustainability, the careful selection of indicators reflecting all dimensions of the production process and all variables that influence it.

Economic aspects

The economic elements of agriculture are connected simultaneously to the individual interests of the farmer and the interests of the whole region and the society. As a manufacturer of food, each farmer is engaged in this activity primarily in order to satisfy his/hers physical needs and those of their family. If the system does not achieve this, if the farm is not productive and profitable and does not provide for farmer's basic needs - this activity is not sustainable (9). In this study I assess economic sustainability by three indicators: *productivity, profitability* and *net income*.

Productivity is the first and most relevant objective of any farm in the dairy sector, which must meet the needs of the farmer and his family and the increasing demand for milk and milk products worldwide. Furthermore, it's not just high productivity that is important but also maintaining it in the long term. Productivity at farm level and sector level, most easily can be defined as dependant on the number of dairy cows and their milk yields in a certain period of time. Therefore, for the calculation of this indicator the following sub-indicators can be used: *number of dairy cows* and *milk yield.*

The financially stability of a farm is another important dimension, which determines its long-term sustainability. At farm level the economic performance could be defined as the profit or the income, which the producer earns through the year. This means that the monetary value of all outputs must exceed the value of the resources used. Although the economic viability is related to productivity, it depends on many factors such as demand for milk and milk products, consumer preferences, government policies (subsidies, credit policy), on the prices of products and resources, technology, markets, infrastructure and others (10). The financial status of a farm is calculated by monitoring and analyses of the following indicators: *profitability* and *net income*. Profitability is farmer's ability to make profit from his resources (11). Profitability measures the amount of profit a farm generates through its operations. It shows how well the farm uses its assets and equity to generate revenues and create profit from those revenues (12)

The amount of profit or income, received by economic agents, largely determines their behavior in the business climate and their willingness to continue the current activity or seek other alternatives. Lower income or profits in a particular sector motivate people in searching for other employment or looking for ways to increase their efficiency.

Agriculture is a sector, where traditionally the income earned by farmers and employees is lower than the income in other industries, which makes it economically less sustainable. Different actors in the dairy sector chase different economic interests, which explain why some of them pursue higher profits, while others are satisfied even with minimal positive results. There are several types of farms in Bulgarian dairy sector, both in terms of their size and their specialization and the resources used:

- Large commercial farms, specialized in milk production, or at least the main part of their income comes from this activity. Such establishments usually work with hired labor and their economic policy is based on the possibility and the need of making profit.
- Family farms, which mainly use their own work force. This relatively lowers the dependence on high profit levels, because here salaries are not fixed. According to the Bulgarian Ministry of Agriculture and Food, family farms could be separated on: farms, where milk production is the **only activity** (the cases when the farm is specialized in this, without any other business, the owners do not work anywhere else and do not receive any other income). Milk production is a **primary activity** (when the person works elsewhere, but the bigger share of the time spends on the farm). **Supplementary work** (cases when the person has permanent job with other employer and in the free time works on his/her farm). The milk is used for food or it is sold on the market in order to supplement the family budget. Such farms do not aim at high profits, but rather at additional and diversified income (13).

Environmental aspect of dairy farm sustainability

Although environmental problems are often related to industrial development, agriculture also contributes significantly to some environmental issues: biodiversity loss, overexploitation of water resources, pollution of soil, water and air, greenhouse gas emissions (9). The main purpose of animal breeding is the provision of food for consumers and row materials for the manufacturing industry. Except this, though there are some side products from dairy farming that in specific conditions can contribute to contamination of soil, water and air, as well as to the loss of biodiversity. The dairy industry is characterized with various negative environmental influences, mainly with large water consumption and discharge of pollutants to the atmosphere, the soil and the water.

In this study we have used three indicators to assess the environmental relationship of dairy farming in Bulgaria: *energy demand, biodiversity* and *manure management*

Energy demand **–** One condition for sustainability of milk producing farms is the efficient energy use, which leads to saving of financial resources, reduces the use of fossil fuels and lowers the potential for environmental pollution. By this module we assess the energy requirements of dairy farms, where the most energy-intensive operations are: milking, milk cooling and storage, lighting and ventilation, as well as soil treatments and

harvesting associated with the production of animal feed.

Biodiversity **–** The variability within and among living organisms and systems inhabited by them is the foundation upon which human civilization is built (14). In addition to its intrinsic value, biodiversity provides products and intangible assets that support sustainable development in many important ways. First, it supports the functions of ecosystems that are essential for life on Earth, such as providing fresh water, soil conservation and stable climate. Secondly, it provides products such as food, medicines and raw materials for the industry. Finally, biodiversity is at the heart of many cultural values. The rate of biodiversity loss is increasing at an unprecedented speed, threatening the very existence of life, according to its modern interpretations. Maintaining biodiversity is a prerequisite for sustainable development and as such constitutes one of the biggest challenges in the modern era (14). Agriculture, regardless of farm size (large or small) affects biodiversity in the region through the creation of pastures, arable land, buildings, infrastructure, GMO-application, etc. All this pushes native species and reduces biodiversity, on which in fact depends the functioning of ecosystems. Sustainable agricultural systems that work in favor of biological diversity, by applying environmentally friendly management practices with a low negative impact, may offer an alternative to traditional agricultural holdings. Farmers and agricultural activities can influence positively and negatively the biodiversity, which at farm level includes all the flora and fauna in and around the farm - from micro to macro-organisms, such as worms, insects, trees, birds and others.

Manure management. The benefits of creating and implementing a sound manure management program can be in several dimensions:

- To the ecology of the region
- To the economic performance of the farmer
- Compliance with environmental laws and regulations

Manure handling requires the development of an efficient system for removal, storage and use of livestock waste.

Social aspects of dairy farm's sustainable development

Sustainable agriculture, along with economic and environmental objectives must pursue better welfare of the farming community and also of the whole society. From a social perspective, the most important goal of agriculture is meeting the basic needs of the population and ensuring good quality of life for those involved in it. It must be in line with social values, traditions and cultural heritage and has to be able to provide opportunities for access to essential social services like education, health, justice, a place to live, opportunities for development of rural life, and others. There are many indicators that can be used to evaluate social sustainability of farming, but we have choused the ones most suitable in the particular conditions in the country: *quality of farm family life, animal welfare* and *milk quality and safety.*

Quality of farm family life. Very often in areas where agriculture is practiced there are no schools, hospitals, cinemas, theatres, restaurants and other social institutions, which deteriorates the quality of life of the local people. This determines the greater volatility of economic activities in these areas, because people will seek alternatives to leave them at an opportunity for a better and safer place to live. On the other hand, even in more socially developed regions, where social benefits exist and people can use them, if farming does not provide sufficient income and good economic efficiency, farmers will not be able to afford them and again their quality of life would not be satisfactory. By this module of the study We have tried to establish the relationship between the social and economic characteristics of Bulgarian dairy farms, the availability and access to social services as major indicators for sustainability of dairy farms. Tree such indicators have been used:

- *access to education*
- *access to healthcare*
- *social interactivity of the farmer and his family*

Animal welfare **–** Animal welfare is a category of sustainability, defined by the American Veterinary Medical Association as the "human responsibility that encompasses all aspects of animal well-being, including proper housing, nutrition management, disease prevention and treatment, responsible care, humane handling, slaughter and when necessary euthanasia" (15). Animal welfare can be defined from different points of view. Consumers look at the animals and the way they are grown mostly by moral considerations and concerns, as well as the

understanding that a well treated and happy animals according to their physiological requirements later become better quality food. Unlike consumers, farmers look at animal welfare more from technical or economical

aspects. According to most manufacturers, welfare means providing suitable conditions for the animals – complying with technical, legislative and economic considerations. These are: provision of sufficient food and water, good ventilation, cleanliness of the premises, maintaining proper temperature and microclimate, healthcare, waste removal, etc.

The animal welfare and the good body condition are essential to the good results from the production process (16).

Milk quality and safety – Milk quality and safety is associated with the elimination of possibilities milk and dairy products to cause any harm to consumers (17). For the purposes of the study two sub-indicators are used: *Total Number of Microorganisms (Standard Plate Count) and Total Number of Somatic Cells (Somatic Cell Count).* They are easily accessible and understandable. Each farmer periodically receives information from processors for the values of both indices. Food safety is divided in terms of physical, chemical and microbial contaminants. Most dangerous to human health are the negative effects from antibiotics, the dioxins for chemical protection and salmonella. At present, the majority of Bulgarian dairy farms do not meet European standards for milk quality and safety. According to the Ministry of Agriculture and Food's strategy for development of dairy farming and improving the quality of cow milk for the period 2006 – 2009, in conjunction with the requirements of Annex III, Section IX, Chapter I, Part III, pursuant to Article 10, paragraph 8 (b) and Article 11, paragraph 10 of Regulation 853/2004/EU, the dairy farms in the country were categorized into three groups, depending on the condition of their buildings and facilities, and depending on the quality of the milk they produce. The main objective of this strategy comes down to bring our milk producers to the standards set out in Regulation 853/2004/EU, namely by the end of 2009 the parameters of raw milk to become close to 100 000/ml. total number of microorganisms and 400 000/ml. total number of somatic cells. This transitional period was extended for another two years until the end of 2011, after that milk which doesn't meet these benchmarks can not be sell on the market.

CONCLUSIONS

The sustainability function, developed in this study is relevant when evaluating different tips of farms. It should be noted though that the selected set of indicators should not be considered as appropriate in all cases. It may be necessary to develop a framework for the assessment of farm sustainability. After that suitable indicators should be selected to fit to the particular conditions. It is not necessary to use too many indicators. It is better to work with a few but well chosen indicators.

In order to be exhaustive and useful the indicators should be selected on the bases of well-organized and structured information which in turn requires a methodological framework for measuring the sustainability of the farms, by proper tools and organizational approaches that transform raw data into useful information, coherent with the basic concept (2, p.13).

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