

Sustainable development through designing and implementing of environment-friendly technological solutions

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Abstract

The context of approaching such a thematic is as worrying as it is mobilizing because it depicts the agriculture in collapse, affected by various forms of pollution, partly under the influence of its activities, but also because of other human activities. Thus the watchword is change, which must start with reducing the consumption of both food and energy, and especially of natural resources.

A change is needed because food has in its main structure, the agricultural product resulted from the functioning of the agro-system and it is the expression of the quality of its resources.

The ecological status of the soil has suffered from specific technological links of intensive agriculture and can be restored with their help, respecting the principles of sustainability. In order to be able to protect the environment, it is important to start putting into practice the sustainable agriculture systems, where the central idea is to rebuild the soil by observing the principles of biology and ecology.

This paper begins by presenting major human errors encountered in private farms based on which a diagnosis is made on the studied agro-system. Once the diagnosis is made, there follow the design and elaboration of a reconstructive system based on sustainable agriculture placed in a 5-year rotation. The objective of the reconstructive system is to lead to a revival of agricultural production starting from the study of natural models and their intensification within the limits of ecological laws.

Keywords: Agro-system, biological, ecological, fertility, soil, sustainable technology

1. Introduction

Approaching the theme of sustainable development of agriculture is an emergency resulted from the fact that agriculture polarizes the economic life of the countryside and it is a strong advocate of the quality of life. The need for this approach resulted from many existing information in the literature on soil erosion caused by the practicing a destructing policy of “protective vegetation”, especially in the second half of the last century, through intensive works of deforestation, overgrazing and excessive plugging. The result was the loss of soil accumulated over a long geological periods (L. Brown, R. [1]).

The context of addressing issues of sustainable development of agriculture is defined on the one hand, by the worrying reality of soil condition on a large global scale, amid farming practice of an agriculture failing to observe the biology and ecology laws, and on the other

hand, the challenge of promoting a different kind of agriculture based on soil reconstruction and on observing the principles of biology and ecology. This reconstruction is imperative for approximately 5 million hectares of arable soils that Romania holds and it can start by changing attitudes towards how the soil is being exploited (M. Berca [2]).

Developing this theme takes into account the fact that “the farmer carries great responsibility for the protection of nature and environment” (Rojanschi V. [3]) and the sustainable development of agriculture requires increased production capacity while maintaining the resource base natural. For this goal, ever since the years 1970 – 1975, the Club of Rome had stated that “modern agriculture can become sustainable” (that is ecological), that “the western agriculture models can be replaced with self-sustaining methods to enrich the soil instead of impoverishing it, to produce more food energy than it consumes and to obtain abundant and high quality harvests.”

The relevance of such a theme is based on the fact that agricultural development was done a long time on account of irrational exploitation of natural resources. This led to an evolution in economic, technical and political transformations leading to major negative implications especially at the level of the main rural activity – the agriculture. These changes have resulted in changing the life of rural residents and the relations between the rural and urban areas respectively drastic reduction of natural resources, putting them in danger, and not least the impoverishment of the rural population. It is noted the need for a change in the agricultural production, able to lead to its sustainable development, responsible in terms of environment and socially equitable. This change is born from the need to feed cheaper and better by restoring the ecological balance, increasing the competitiveness of agribusiness organizations, based on the adhesion to the European Union, where regulations are becoming increasingly stringent and those who succeed are the ones who develop and implement solutions favoring the future trend for future sustainable development of agriculture. In essence sustainable development implies, in the current context synthesized by this dualism of eco-system versus eco-efficiency, the care of humanity towards the current and future situation of its natural resources, energy, materials and information (Zaman and Gerasimos [4]).

The way sustainable development of agriculture can be achieved is becoming a growing problem today, to which we will try to provide an answer below. Please note that for this, a crucial role lies in the assessment of agricultural activities in order to capture their specificity, in order to develop solutions that will promote responsible agriculture in terms of environment and socially equitable. For this purpose, a land research was conducted in the countryside of Sibiu Depression to develop sustainable agriculture by designing and implementing environment-friendly technological solutions.

Sibiu Depression is located in central Romania, namely in the southwestern hills of Transylvania Basin and the northern Carpathians, namely in the northern mountains and Cindrelului and Lotrului mountains whose altitude is between 380 and 602 m (Sandu [5]). The means, by which one can adopt the most relevant solutions for sustainable development of agriculture in the investigated rural areas, is to identify the principles that are the foundation of technology strategies geared towards replacing agriculture inputs and conservative - polluting technologies with the natural-reconstructive ones.

The paper recommends that the accountable local factors to assess the agricultural activities performed in order to answer to certain “strategic” questions such as: Where are we?, Which way should we go?, What changes and rhythms are there in the environment?, What course of action contributes to establishing the objectives and goals set?

For the success of the approach in this research, based on the study of literature in the field of sustainable development of agriculture and assessment of the state of agriculture in rural areas in Sibiu Depression, the following lines of research were addressed: diagnosis of the condition of agriculture and assessing the potential for sustainable development; the principles of soil exploitation in sustainable agriculture and the main systems of works aimed at their implementation and consolidation; promoting the need for an eco-technological transformation of agriculture and an “education” system for farmers / consumers thereof; implementing new technologies in private farms and their impact on the state of its economic and environmental state.

Research goals

Our research being connected to the current state of development of agriculture and to the need for sustainable development, it focused on increasing the quantity and quality of agricultural production so as to ensure food security for the population, increasing its contribution to foreign economic exchanges, in compliance with the requirements for the environmental protection and improvement. Thus, the overall objective of the research paper is the developing, implementing and promoting of sustainable farming practices relevant to protecting the environment and improving the quality of agricultural products. In order to achieve the main goal, the following four specific objectives have been set out:

SO1. Diagnosing the state of agriculture and assessing the sustainable development potential in rural areas examined;

SO2. Developing/identifying and recommending the sustainability techniques, connected to rural area reality, that promote a unitary and coherent set of criteria and principles for the sustainable development in order to increase efficient use of human, natural, energetic, material and informational resources and to enable restoration/maintenance of soil fertility and of ecological balance;

SO3. Raising awareness and education amongst farmers/consumers regarding the impact of sustainable agriculture over the environmental protection and human health as a result of the bio and eco-economy principles;

SO4. Creating an appropriate framework for the transformation of intensive agriculture based on continuous and progressive allocation of non-renewable resources in sustainable agriculture, based on the allocation of renewable resources produced on biosphere, means of restoring the ecological balance.

2. Materials and methods

The research methodology was based on multiple analyses of statistical data and bibliographic material referring to the state of agriculture in the rural areas investigated. Statistical information was selected and ranked according to its importance for the objectives pursued. The main parameters focused indicators regarding: the cultivated areas, productions, pluriactivity within the agricultural economic organizations.

Data collection during the field research included a variety of tools. It began with a questionnaire – a tool for quantitative research, the filling of which was based on quantitative data complement existing at the LAU2 level (commune) taken over from various sources (official statistics at the LAU2 level, statistics on local businesses territorial development plans, monographs, research, studies, projects, data on population, soil exploitation method).

This information was completed furthermore with primary data as a result of conducting a collecting process for items not covered with information in official documents. They obtained information led to the depiction of a realistic picture, but not encompassing the issues of sustainable agriculture in rural areas investigated. This prompted the organization to

organize a semi-structured interview with key local stakeholders. The interview is based on the idea that by formulating open questions, the liable local factors can identify opportunities and constraints regarding the sustainable development of agriculture. The interview was held in the form of focus-group meetings to highlight new problems from a small number of subjects (Kruger [6]). Conducting the interview in focus-group meetings enabled the collection of quality data on migration, the set-up and the development of businesses, the attractiveness of the area, information and consultancy.

SWOT analysis was used to stress on the strengths and weaknesses (from the internal environment), on the opportunities and threats (from the external environment). (Ilies [7]) It is the premise of training strategies for sustainable agricultural development that support the future development of rural development policies.

The combination of these elements outlines four quadrants which correspond to four strategic groups (Nistorescu Sitnikov [8]). Two of them group active strategic alternatives oriented towards the exploitation of the identified opportunities, by reducing or eliminating weaknesses. The other two group passive strategic alternatives focused on countering threats from the external environment by harnessing its forces and minimizing weaknesses. The purpose of strategic alternatives generated by the SWOT analysis is to build up strengths so as to be able to exploit opportunities, counter threats and improve weaknesses (Ritson [9]). Ideas on sustainable development of agriculture in rural areas researched are developed with the involvement of affected groups (farmers, members of local authorities, members of community NGOs, researchers, etc.).

3. Results and discussions

The research methodology adopted enabled us to obtain relevant information in accordance with the objectives of the research and led to the identification of problems and the potential for sustainable development of agriculture. Applying both quantitative and qualitative research methods made it possible to highlight specific elements of the countryside in Sibiu Depression on agriculture and to obtain a better orientation of strategic measures for sustainable development of agriculture.

Sustainable development of agriculture is a part of the rural development and it is politically coordinated through CAP (Common Agricultural Policy). According to the “2020 Europe” strategy, the goal of CAP is to find the best solutions for economic, environmental and territorial problems. It is primarily aimed at promoting environmental services and agricultural practices observing the preservation of farmland and forests.

The diagnosis of the state of agriculture and the assessment of its potential for sustainable development in rural areas of Sibiu Depression show that:

Agriculture polarizes the economic life of the countryside in Sibiu Depression and it is the main occupation and source of income for the inhabitants. The utilized agricultural area in the countryside of Sibiu Depression registered 37754.84 ha in 2010, which means an average on the agricultural exploitation of 4.9 ha utilized agricultural area (Iagăru [10]). Land use in rural areas from Sibiu depression shows a 22.27 % arable land, 0.86 % household gardens, pastures and hayfields 71.74 %, 5.35 % permanent crops (Iagăru [10]) . A study on the data on crop production shows that grain cereals went through an ascending line in the period 2007-2010 and registered for wheat crop an average of 2871 kg ha maize grain with an average production of 4034 kg per ha. The average production obtained for potatoes reveals a decrease in 2010 compared to the average production for the period 2007-2010. Production of fodder plant registered in 2010 productions close to the average productions for 2007-2010 (Iagăru [10]).

In conclusion, we consider that within the development sector of crop production there is a grouping of crops in terms of average production dynamics, as follows: decreasing trends for maize and potatoes constant for perennial forage, alfalfa, clover, vines and orchards, namely an upward trend for wheat and barley. Animal breeding is a traditional occupation in the rural Sibiu depression and the area occupied by pastures and hayfields in total utilized agricultural area confirms this. The level of technical equipment available to agriculture in Sibiu Depression is not able to ensure works in the optimum time, but there are farmers' initiatives to change the classical industrial technology with modern oriented sustainable agriculture techniques.

Analysis of the results obtained, following the assessment of the state of agriculture in the rural farming of Sibiu depression highlights our agriculture dependence on climatic conditions and an orientation towards technological links belonging to intensive agriculture, which requires taking strategic steps necessary to protect the agricultural activity and to promote new environmental reconstruction.

Information obtained by using secondary analysis of statistical data with the results from the semi-structured interviews led to the conduct of SWOT analysis. It is commonly used to identify strengths and weaknesses, external opportunities and threats of an organization or territorial units (Vincze et al. [11]). SWOT analysis included a significant number of strengths and weaknesses, opportunities and threats which led to the organization of focus-group meetings with local responsible stakeholders and professionals where relevant opportunities and threats for each of the strengths and weaknesses through the sustainable development of agriculture were discussed. The results have enabled a brief SWOT analysis (Table 1) whose interpretation shows that natural resources and tradition of animal breeding are the main factors for the sustainable development of agriculture.

Achieving sustainable agriculture in rural areas in Sibiu Depression is provided by the main strengths identified, such as: the natural resources favorable to agriculture and agro tourism, the tradition, the popular brands, the continuous improvement of agricultural specialists and workers; providing expert advice, namely the existence of two industrial parks in the municipalities of Selimbar and Sura Mica.

The SWOT analysis shows the existence of problems of sustainable development as a result of weaknesses existing in the rural Sibiu Depression such as: the lack of necessary knowledge to attract European funds for most of the farmers, the lack of development strategies and sustainable visions, high costs for upgrading technology, poor educational infrastructure and decreasing acreage and number of animals. Sustainable development of agriculture is under the influence of threats such as: the low interest regarding the association of farmers, the local decision makers' inability to create partnerships to attract funds, the lack of policies and strategies to promote and support their products in rural areas, namely migration of specialists and labor force. What could help more the sustainable development of agriculture is a better exploitation of the opportunities present in the rural area of Sibiu Depression. Out of them all, focus must be placed on: the possibility of accessing funds for sustainable development of agriculture, agro tourism, physical infrastructure, namely agricultural services.

Table1. Brief SWOT analysis

STRENGTHS		WEAKNESSES	
S 1	Natural resources favorable to sustainable agriculture and agro tourism	W 1	Lack of necessary knowledge to attract European funds for most of the farmers
S 2	Brands popular nationally and internationally	W 2	Lack of development strategies and sustainable visions
S 3	Animal breeding tradition	W 3	High costs for upgrading technology
S 4	Continuous improvement of agricultural specialists and workers and providing expert advice	W 4	Poor educational infrastructure and
S 5	Industrial parks in the municipalities of Selimbar and Sura Mica	W 5	Decreasing acreage and number of animals
OPPORTUNITIES		THREATS	
O 1	The opportunity of accessing national and european funds for the sustainable development of agriculture	A 1	Low interest regarding the association of farmers
O 2.	The opportunity of accessing national and european funds for the sustainable development of agro-tourism	A 2	Local decision makers' inability to create partnerships to attract funds and implement projects
O 3	The opportunity to develop the physical infrastructure by means of financing programs	A 3	Migration of specialists and labor force towards foreign countries
O 4	The opportunity to develop agricultural services by means of financing programs	A 4	Poor development of IT and communications
O 5	Favorable influence of European organism on decision makers	A 5	Lack of policies and strategies to promote and support agrifood products obtained in the rural area

The results are relevant for development and the implementation of policy options that lead to sustainable development of agriculture in rural areas in Sibiu Depression.

These are grouped as follows:

Support the implementation, the development of sustainable agriculture and the agro tourism. This requires the adoption of specific measures that will lead to a better exploitation of the natural resources favorable to the sustainable development of agriculture and rural tourism by increasing the attractiveness of the area investigated.

Promote the implementation and development of sustainable agricultural production activities and marketing of agricultural products represent strategic option which encourage the promotion of sustainable agriculture techniques and the increasing the quality and visibility of agricultural and food products produced in rural areas of Sibiu Depression. This creates the appropriate framework for the transformation of intensive agriculture, based on continuous and progressive allocation of non-renewable resources in sustainable agriculture, based allocation of renewable resources produced by biosphere, means of restoring the

ecological balance; Also contributing to the satisfactory completion of specific products and rural traditions of Sibiu Depression.

Development and promotion of information and advice services for the residents of rural areas and the local government staff with the goal of accessing funds for rural development. It is the strategic option which helps to increase awareness of farmers /consumers about the impact of sustainable agriculture on the environmental protection, respectively to increase the absorption of funding and implicitly to the sustainable development of agriculture and rural tourism in rural areas of Sibiu Depression.

The strategies elaborated help ensure the strengthening of those elements with a major impact on the formation and development of a new agriculture, namely – increasing competitiveness, development based on the principles of the market economy, the production of healthy and cheap, increase farmers' income – (Belli, N. Dumitru, D. Popescu, M., Teodoroiu, F. [12]).

In conclusion, a strategic framework is formed with a focus on the objective of achieving sustainable development of agriculture in rural areas in Sibiu Depression.

The means by which one can obtain a sustainable development of agriculture in rural areas in Sibiu Depression is the designing and implementing of a system for performant sustainable agriculture in which the new sustainability techniques are promoted , as well as new species like *Phacelia tanacetifolia*, a species with multiple uses (honey, fodder, green manure) recommended to rebuild the soil.

The projected system of sustainable contributes to protecting and improving quality in the damaged environment, as well as to the rebuilding of the soil degraded due to agricultural practices that do not observe the laws of biology and ecology.

This will lead to avoiding the production of “... food from plants grown in contaminated soil and implicitly, to avoiding serious diseases such as: cancer, poisoning, genetic mutations” (Banu A., Radiv O., M. [13]). Within the system designed a special attention is paid to the integrated management of land, water and living resources which promotes conservation and sustainable use in an equitable way.

The need to promote sustainable farming systems, which are based on fertility status loss, is generally attributed to excessive use of the plough and to oversized doses of nitrogen applied on soil (Ragamm [14]), blockages caused by hardpan (M Berca [2]) and soil erosion (Brown [1]).

The designed system aims to promote structures that enable a rotation of five years because it reduces costs by 20 - 40% and restore soil structure. The structure of cultures promotes using the plants which preserve permanently covered soil (triticale, maize and potato), alfalfa, legumes (peas) and plants used as green manure (phacelia) and can be seen in Table 2.

Table 2. Structure and crop rotation within the designed system of sustainable agriculture

2013	2014	2015	2016	2017
Peas	Triticale	Corn	Phacelia	Potato
Triticale	Corn	Phacelia	Potato	Peas
Corn	Phacelia	Potato	Peas	Triticale
Phacelia	Potato	Peas	Triticale	Corn
Potato	Peas	Triticale	Corn	Phacelia
Alfalfa	Alfalfa	Alfalfa	Alfalfa	Alfalfa

Culture technologies of crop plants mentioned in cropping patterns are developed according to the requirements on sustainable development of agriculture (Table 2) and comply with the following principles: preservation principle (subordinate works to soil restoration and conservation and its relations with crop plants); principle of minimum intervention (the smaller number of works, the better principle of no. 1 will be complied with); the principle permanent green or covered (provide a permanent coating for soil either green or covered with organic matter); the principle of sustainability (use of machinery and technologies so as to ensure within a given time the permanent restoration to natural forms that characterized it).

Table 3. Crop technologies with elements of sustainable agriculture

PEAS	TRITICALE	CORN	PHACELIA	POTATO	ALFALFA
organic fertilization	organic fertilization	organic fertilization	organic fertilization	organic fertilization	superficial ploughing
ploughing without turning the furrow	ploughing without turning the furrow	autumn ploughing	ploughing without turning the furrow	autumn ploughing	discing land
discing land	discing land	discing land	discing land	discing land in spring	preparing soil
preparing germinative soil	preparing germinative soil	preparing germinative soil	preparing soil	preparing soil for sowing	preparing germinativ soil
sowing	sowing	sowing	preparing soil for sowing	potato sowing	sowing
fertilizing	spring fertilization	hand hoeing	sowing	biological material resistant to mildew and less pretentious	roller after sowing;
cropping	cropping	mechanical hoeing	roller after sowing	restoring billon	grooming field
		cropping	weeding;	hand hoeing and restoring billon	mowing I + 2;
			cropping	phytosanitary treatments;	hay spreading
				destroying brushwood;	packing
				cropping;	
				sorting	

The mechanisms of plant nutrition are reconsidered taking into account the respect for the environment, according to the new principle of “refreshing the green revolution” amid application and use of natural cycles (Berca M. [2]).

Nutrient application must comply with the following principles: the first nutrients to be applied are those produced by nature (composts, green manure, organic waste); basic nutrients of plant will be applied in the same order, firstly the natural ones and then the synthesis ones;

nutrients will be applied after careful monitoring of the balance between soil supply and plants needs; plant nutrition system must be accompanied by continuous improvement of the ecological status of the soil. Maintaining crops also requires a specific activity with a major influence both on production and on soil characteristics; the paper being focused towards eliminating stress caused by weeds, diseases and pests.

4. Conclusions

Maintaining the balance between the factors of production, their scientific dosage consistent with the biological requirements of plants and with local climatic conditions is essential for sustainable agriculture. The designing of sustainable agriculture includes environmental friendly technological solution which is consistent with the concerns of researchers from around the world.

Changing the conservative-polluting technologies with the natural-restoring ones will lead to the development of a new sustainable agriculture able to offer a multitude of advantages compared to known effects of existing products and technologies: enriching soil organic matter; lower costs; higher labor productivity; reduce fertilization, pesticide poisoning and other soil poisoning; improving soil biological activity both quantitatively and qualitatively; restoration of soil structure; restoring soil nutrient reserves and optimize relationships type plant-soil; farmers' awareness on the natural values of the land. Addressing sustainable development of agriculture helps to identify the principles that are the foundation of technology strategies geared towards replacing agriculture inputs and conservative-polluting technologies with more natural-preserving ones.

Imposing the sustainability principles is not an easy task, but the impact of the results obtained on protecting the environment and ensuring welfare support all the necessary effort.

Spreading the information about sustainability from specialists to the general public (farmers / consumers) represents the catalyst of the process of implementing the principles of sustainability as it leads ultimately to educate the population in the spirit of the requirement and implicitly towards producing quality products that are not obtained at the expense of the environment and human health.

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