

BIODYNAMIC AGRICULTURE AN ALTERNATIVE TO CONVENTIONAL AGRICULTURE: A CASE STUDY OF TRANSILVANYA AREA, ROMANIA

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Abstract

The delimitation of the research topic has as a starting point the problematic situation represented by the unfavorable effects on the environment and food safety caused by chemical agriculture. Biodynamic agriculture, through its peculiarities, represents an alternative for farmers concerned about environmental health and obtained products. The elaboration of a questionnaire and its application on a sample of 95 farmers from the Transylvanian Plain and Plateau, Romania has consisted an important support for revealing their perception on biodynamic agriculture. Our research results allow us to conclude, at least in this phase, that biodynamic agriculture, although little known among farmers, can help protect biodiversity and the environment, and biodynamic farms can be profitable due to the increased interest of consumers for healthy products

Key words: *biodynamic agriculture, sustainability, farmers' opinion, yield, profitability.*

INTRODUCTION

Sustainable farming methods have emerged in the 20th century throughout the entire developed world due to the imperative need to protect the environment and food safety, as a response to the negative effects of industrial agriculture (Gradi et al., 2014). According to (Crippa et al., 2021) food systems are solely responsible for a third of the global greenhouse gas emissions. Biodynamic (BA) or sustainable agriculture has become the subject of research efforts in recent decades (Turinek et al., 2009; Beluhova-Uzunova et al., 2019), which are carried out in all agricultural fields and in many places around the world, being reported worldwide as an appropriate system for the conservation or even regeneration of natural resources (Robusti et al., 2020). Biodynamic agriculture is similar to organic farming in many ways (Heimler et al., 2009) both "respect the normal functioning of ecosystems, avoiding the usage of agrochemicals and lead to food" free "of synthetic chemicals, thus healthier (Carvalho, 2006).

According to Demeter, the subject of quality has consisted an important aspect ever since its

beginning (www.demeter.net). The purpose of the two agricultural systems is to maximize the synergies between the farm and the ecosystem (Altieri, 1999); the farm resembles to nature by conserving and recycling resources, requiring minimal external inputs and thus minimizing waste and pollution (Altieri, 2012).

Organic farming is one of the most widely known sustainable models of agricultural production (Antczak, 2021). The difference between organic and biodynamic agriculture, apart from philosophical and historical aspects, is made by the use of biodynamic preparations containing specific herbs or minerals, treated or fermented with animal organs, water and/or soil (Reganold & Palmer, 1995) above these, taking care of the soil rests one of the cornerstones of bio-dynamic ideology (Kaltoft, 1999). The eight preparations prescribed by Steiner for biodynamic agriculture are numbered from 500 to 5007, the first two being used for field preparation, while the last six are used for composting (Nabi et al., 2017) all improving the harvest's yield and quality (Ram, 2019). Therefore, biodynamic farms operate in a circle that improves climate change mitigation and the future of food, plants and animals (Figure 1).

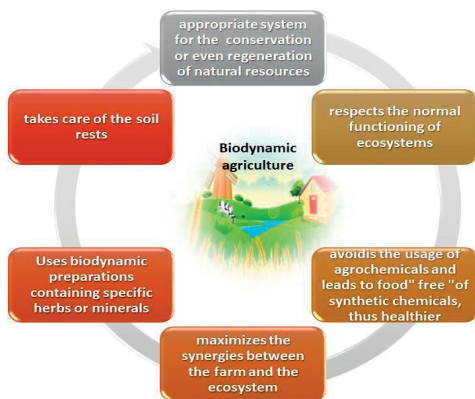


Figure 1. Synthesis of the literature review

Historically, biodynamic agriculture dates back to the early 1920's when Rudolf Steiner, the undisputed founder of the biodynamic method, became concerned with environmental pollution and the exploitation of natural resources (Diver, 1999). The editors of *Alchemy of the Everyday*, the catalog of the retrospective exhibition of Steiner's work, describe Steiner as "one of the most influential - but also controversial - reformers of the twentieth century" (Vege sack, 2010). The biodynamic approach is based on eight lectures for farmers ("Spiritual foundations for agriculture renewal: a series of lectures.") Given by Rudolf Steiner in 1924 at the Koberwitz farm near Wrocław (formerly Breslau) (Steiner, 2004). Compared to organic farming, biodynamic farming is more of a life philosophy, a healthy lifestyle that cannot exist without a direct and peaceful connection with nature) (Ponzio et al., 2013). As pointed out by (Bloksma & Struik, 2007), a healthy organism from a biodynamic perspective is not only a "healthy", resilient and sustainable agroecosystem, locally adapted, but also includes the socio-cultural and spiritual dimension, because agriculture itself represents an interaction between human and environment and is being embedded in a cultural environment (Brock et al., 2019).

In farms from Western Europe, biodynamic agriculture represents a new trend, with chances that, in the coming years, to make forgotten organic farming, especially since the new farming community is all about the integrated concept with a peaceful link between agricultural production and nature (Turinek et

al., 2009). Completely eliminating chemicals from farm life, makes possible solving environmental pollution, and the yields obtained, although smaller, are offset by the fact that they present superior biological and nutritional qualities (Papacostea, 1993; Stan, 2005) and they can be traded at higher prices compared to those obtained from conventional agriculture.

Nowadays, biodynamic agriculture (Figure 2) is practiced by approximately 6,400 farmers (www.demeter.net) in 55 countries (30.0%) of the 186 countries reporting organic farming and in a subgroup of 251,842 certified biodynamic hectares (0.35%) of the total global of 71,514,583 certified organic hectares (Paull & Hennig, 2020) and the agricultural method has a very good reputation among the consumers of organic products (Brock, 2019).



Figure 2. Map of biodynamic agriculture

(Adapter after <https://www.freeworldmaps.net/download/maps/world-outline-map.jpg>, and <https://database.demeter.net/oppub>)

Currently, in Romania there are very complex agricultural systems, their complexity being determined by natural and socio-economic conditions, the developmental level of science and technology among the evolution of human society. According to (Gradi et al., 2014) the most widely used agricultural systems are the conventional and organic one, the last one being practiced on only 3% of the total agricultural area of Romania (www.madr.ro). Research regarding the perception of Romanian farmers on organic farming are consistent (Petrescu, 2017; Ionela, 2016; Petrescu-Mag et al., 2019; Roșca et al., 2012) while those on biodynamic agriculture are non-existent, probably because biodynamic agriculture is an agricultural method challenged or even rejected, being considered unscientific.

Neither the literature regarding the practice of biodynamic agriculture and food safety is very

consistent, there are some research related to: agricultural systems practiced in Romania (www.madr.ro), the conversion from conventional to organic and biodynamic agriculture system (Buhler & Constantinescu, 2020) autumn wheat culture technology (Tomsa & Morar, 2013), and support for food safety and security provided by biodynamic farms (Negrei, 2017).

Although, biodynamic farmers are still a minority in Romanian agriculture, only 5 farmers being certified by Demeter or in the conversion period, of which two are found in the research region (Figure 3) (www.demeter.net), the fact that our country still has free/virgin lands that have not been yet cultivated or chemically treated and by founding the Association for the Development of Biodynamic Agriculture in 2021 (<https://biodinamica.ro/>) we hope to increase the interest in such agricultural practices in other farms as well.



Figure 3. The situation of biodynamic farms in Romania in 2021 (<https://database.demeter.net/oppub/all/all/all/all/all/all/ro>)

MATERIALS AND METHODS

While the conversion from conventional to organic agriculture was targeted by many authors, researches regarding biodynamic agriculture are still in the pioneering phase in many countries, and especially in our country. Therefore, evaluating the opinion of the Romanian farmers, and especially of those from the Transylvanian Plain and Plateau (Figure 4) regarding the biodynamic agriculture represents the main contribution of our work.

The questionnaire based research method aimed to collect data from respondents. The sample consisted of farmers from the Transylvanian Plain and Plateau, Romania.

A questionnaire of 18 questions was applied in the period 2020-2021 in online mode due to the

pandemic situation given by SARS-CoV-2 virus, but also in order to save time and money.

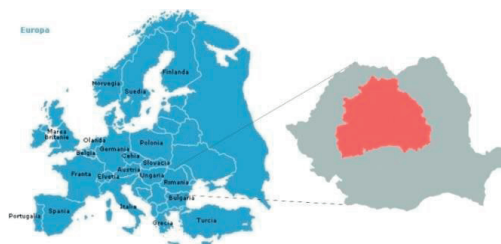


Figure 4. Transylvanian Plain and Plateau

A total of 95 questionnaires were validated, and further on, were analyzed. In order to analyze the data, we used the methods related to descriptive statistics, respectively the analysis of frequencies, in order to understand group tendencies. In order to identify the general trend and variability, the related parameters were calculated: for the general trend (average, median, sum of series values), and in order to calculate the parameters of the central trend of distribution and spreading - standard deviation. The questionnaire is divided in four main parts, involving: questions related to the agricultural situation of the respondents; questions regarding the concept, the intention to convert to biodynamic agriculture and the environmental implications deriving by practicing this type of agriculture; questions related to product quality and sales market, yield and profitability, and the fourth part was represented by questions related to socio-demographic aspects of the respondents.

RESULTS AND DISCUSSIONS

The main aspects that were taken into account in the present research were grouped into five categories of results.

Respondents profile.

The socio-demographic characteristics of the respondents are presented in Table 1. From the total number of respondents (Table 1) 71.1% are included in the age category of 18-30 years old, have graduated from university studies (78.9%), possess as well other specialized studies (68.4%), practice farming in the conventional agricultural system (74.7%) and are mostly residents (43.3%) from Cluj County.

Table 1. Socio demographic data

Characteristic	Category	Percent %
Age	18-30 years old	71.1%
	31-40 years old	16.5
	41-50 years old	4.2
	Over 50 years old	8.2
Level education	Vocational studies	2.1
	High school	18.9
	University degree	78.9
Possess other specialized studies in the field	Yes	68.4
	No	31.6
County of origin	Cluj	68.4
	Mures	31.6
	Bistrita	
The agricultural farming system practiced	Biodynamic agricultural system	1.1
	Conventional system	74.7
	Ecological system	17.6
	Conventional + ecological	3.9

Results regarding the agricultural situation of the respondents.

In order to establish the agricultural situation presented by the respondents, some information considering the surfaces situation of the owned holdings were requested on. There have been identified five categories of holdings which are summarized in Table 2. This decision, to have a diverse sample of holdings, was made from the desire to generate as diverse responses as possible. As mentioned in the Material and Method section, respondents were residents from the Transylvanian Plain and Plateau. These regions produce a diverse range of agrifood products in Romania (Oroian, 2018) due to the geographic characteristics that they possess.

Table 2. The share of owned holdings

Category	Percent
Field crops	62%
Vegetable crops	36%
Orchards	20%
Vine	12%
Zoototechnics	55%

Respondents opinion regarding the biodynamic agricultural system.

Biodynamic agriculture is a recognition of the basic principles that exist in nature and at the same time an approach to agriculture that takes these principles into account in order to bring balance and healing, without the need for chemical interventions (Vlahova & Arabska, 2015a). Deepening the survey by analyzing the

knowledge of the biodynamic agriculture concept among the surveyed farmers we note that only 37.9% have information about this type of agriculture, while 62.1% are not familiar with the concept (Table 3). This may be due to the lack of information sources considering this type of agriculture.

Table 3. The knowledge of the biodynamic agriculture concept

Variable	Freaquency	Percent
Yes	36	37.9
No	59	62.1
Total	95	100.0

By analyzing the intention to adopt the principles of biodynamic agriculture, it was found that 18.9% of respondents want to adopt this agricultural system, while 81.1% are not interested. The explanation of this phenomenon can be given by the fact that when conventional lands are transformed into organic, respectively biodynamic, the farm becomes less efficient. The analysis of socio-demographic data at 2 groups level using chi-square test and Fisher's Exact test did not find significant differences between the two groups in terms of socio-demographic characteristics, except for the currently practiced cultivation system (Table 4). In the case of the group that wants to adopt the biodynamic agriculture system, the share of those who cultivate in a conventional system is 61.1%, compared to 77.9% in the case of the second group that does not want to adopt the principles of the biodynamic agricultural system. The share of those who cultivate in the ecological system is higher in the case of the second group (18.2%), compared to 16.7% in the case of first group. It was also found that 16.7% of those from the first group practice both conventional and ecological systems, while in the case of the second group only adopted the mixed system.

A study conducted by (Trujillo - Barrera et al., 2016) revealed that risk perception has a negative effect on the adoption of sustainable practices, especially when one's existence is at stake. Studies have found that organic and biodynamic farmers are more prone to risk than conventional farmers (Flatten et al., 2015; Gardebroek, 2006). However (Pechrová, 2014) states that if farms are subsidized, farmers are motivated to switch to biodynamic agriculture,

as they see subsidies as a significant addition to their income. Regarding other determinant factors, (Lohr & Salomonsson, 2000) highlighted that access to multiple outlets and sources of information are important for farmers and replace the level of payment according to farmer's utility. Thus, they concluded that services, rather than subsidies, can be used to encourage the transformation into organic, respectively biodynamic farming.

Further was analyzed the perception of those who want to pass to the biodynamic agricultural system regarding the principles of this crop system (Table 5). Thus, a set of 6 statements were evaluated. It was found that 72.2% of the respondents agree that the biodynamic agricultural system respects diversity and

biodiversity by stimulating the recycling of substances and chemical elements (4.56 ± 0.784), while 66.7% totally agree that the farm represents a unitary organism that integrates plants, animals and humans (4.50 ± 0.786). Respondents are less in agreement with the statements according to which cosmic rhythms influence plant growth (3.78 ± 1.437), respectively that biodynamic preparations emanate forces through which the elements inside plants and animals are organized (3.72 ± 1.274).

The research continued by identifying farmers' opinion on the implications of practicing biodynamic agriculture on the environment (Table 6).

Table 4. Intention to convert to the biodynamic farming system

	Characteristic	I intend to adopt the	I do not intend to	Chi-square test/Fisher's
		biodynamic agriculture principles N=18 (18.9%)	adopt the biodynamic agriculture principles N=77 (81.1%)	
Age	18-30 years	10 (55.6%)	58 (75.3%)	$\chi^2=3.104$, $df=3$, $p=0.373$
	31-40 years	5 (27.8%)	10 (13.0%)	
	41-50 years	1 (5.6%)	3 (3.9%)	
	>50 years	2 (11.1%)	6 (7.8%)	
Level of education	Vacational studies	0 (0.0%)	2 (2.6%)	Fisher's Exact test $p>0.05$
	High school	3 (16.7%)	15 (19.5%)	
	University degree	15 (83.3%)	60 (77.9%)	
Study in the field	YES	13 (72.2%)	52 (67.5%)	$\chi^2=0.149$, $df=1$, $p=0.700$
	NO	5 (27.8%)	25 (32.5%)	
Agricultural system	Biodynamic agriculture	1 (5.6%)	0 (0.0%)	Fisher's Exact test $p<0.05^*$
	Conventional	11 (61.1%)	60 (77.9%)	
	Ecological	3 (16.7%)	14 (18.2%)	
	Mixed	3 (16.7%)	3 (3.9%)	

Table 5. Statements regarding the principles of biodynamic agriculture

Statements	Appreciation scale (%)					Mean	St. dev.
	1-total disagreement						
	5- total agreement						
	1	2	3	4	5		
Cosmic rhythms influence plant growth	12.2	16.6	14.6	22.0	36	3.56	1.432
Quality is a priority element that influences organisms	0	4.9	14.6	24.4	56.1	4.31	0.906
The farm is considered to be a unitary organism that integrates plants, animals and people	0	0	22.0	26.8	51.2	4.29	0.813
Diversity and biodiversity are respected by stimulating the recycling of chemical substances and elements, as well as the exclusion of polluting elements.	0	7.3	22.0	19.5	51.2	4.14	1.013
Biodynamic preparations emanate a force through which the elements inside plants and animals are organized	9.8	14.6	22.0	29.3	24.0	3.43	1.285
Rational farming techniques are applied, whether they are new or old	0	4.9	31.7	24.4	39.0	3.97	0.961

Thus, over 58% of the respondents believe that biodynamic agriculture influences the environment very much, while over 23% believe that it influences much the environment. The influence of biodynamic agriculture on the environment consists in maintaining the well-being of the environment, there is an increase in biodiversity and a sustainable development. Greenhouse gas emissions are responsible for global warming and climate change (Aishwath, 2007). Compared to conventional agriculture, the practices of biodynamic farming have proven to be more resistant to environmental challenges, to encourage a diverse biosphere and to be more energy efficient. Biodynamic farming has an increasing importance in the face of climate change (Lichtfouse, 2018), energy deficit and population growth (Padmavathy & Poyyamoli, 2011). Pergola et al., 2016, when making an assessment on life cycle and energy in integrated and biodynamic apricot orchards, noted that biodynamic production had a lower impact on the environment and requires a lower energy demand. A lower impact on the environment was also noted in biodynamic viticulture compared to the conventional system, which may be related to the preference for manual work over mechanical work, reduced use of lubricants and diesel compared to the conventional system (Villanueva-Rey et al., 2014).

Table 6. To what extent does the practice of biodynamic agriculture influence the environment

	Frequency	Percent
Very much	56	58.9
Much	22	23.2
Neutral	10	10.5
Little	7	7.4
Total	95	100.0

Results regarding the quality of the products and the sales market.

Achieving high quality food is one of the main goals of biodynamic agriculture. Analyzing the opinion of the respondents regarding the quality of the products obtained in the biodynamic agriculture system we notice that more than 30% of them consider that they are of superior quality (Table 7). This topic is at high interest compared to other research topics in biodynamic agriculture. The statement regarding the quality of the products can be strengthened by the

researches made by other authors. Jarienè et al., 2017, when analyzing the concentration of total phenolic compounds and the antioxidant activity of DPPH in potato tubers (*Solanum tuberosum*) of the variety Red Emmalie and Blue Congo observed that they increased significantly after the application of the biodynamic preparation of horn silica. Also, Bavec, et al., 2012, when making a comparison between potatoes in biodynamic and conventional agriculture on by quality indices, dry matter content, taste quality, relative proportion of pure proteins and the value of biocrystallization, recorded positive values in those from biodynamic agriculture. Moreover, Vaitkevičienė et al., 2012, detected that the starch content of red-skinned potatoes (*Solanum tuberosum*) was significantly increased by the combined application of manure and horn silica. Bavec et al., 2012 respectively *Fragaria spec.*, D'Evoli et al., 2010 found more ascorbic acid in biodynamic cabbage and strawberries compared with organic and conventional ones. Heimler et al., 2011, identified a lower content of polyphenols in *Batavia lettuce* plants cultivated in the conventional agricultural system compared to the plants content in organic and biodynamic agriculture. Masi et al., 2017, have revealed that in terms of the color analysis, biodynamic apples (BIO-A) showed the brightest skin. Kusche et al., 2015, observed when comparing milk from different management systems, that the highest share of nutritionally valuable fatty acids are found in milk provided from biodynamic systems. In conclusion, as stated by Nabi et al., 2017, the consumption of biodynamic foods increases vitality, reduces allergic reactions and brings an overall improvement in health.

Table 7. Opinions regarding the quality of products obtained in the biodynamic agricultural system

Variable	Frequency	Percent
Yes	29	30.5
No	3	3.2
I don't know	63	66.3
Total	95	100.0

Sales market, yield and crop profitability from biodynamic agriculture

The sales market and the prices of biodynamic products were also investigated in the present research. Unlike conventional farms, marketing plays a major role in biodynamic farms the

biodynamic market being much smaller than the organic one in Romania, and especially in the researched area. Thus, the surveyed farmers stated that by educating the population and encouraging the consumption of quality food, demand will increase and consequently the market will develop. For example, studies conducted by Mann et al., 2012, on the consumption of biodynamic wine have shown that people with higher incomes and urban residents have a more positive attitudes towards this range of wine.

When analyzing farmers' opinions concerning the yield and profitability of biodynamic agriculture compared to organic or conventional agriculture, respondents stated that it can be just as profitable, even if production is lower, as consumers become increasingly interested in consuming healthy products even if that means a higher price for the product. They also stated that profitability can be increased by using elements within the farm in a high percentage and by adding low external inputs, which will result in lower expenses. A number of 14 articles from our database are related with issues regarding the growth and profitability of biodynamic crops. While (Garcia-Yzaguirre et al., 2011; Pechrová, 2014; Vereijken, 1990) revealed that the yields of the studied biodynamic crops were lower compared to conventional plots, (the prices of biodynamic products were up to 25% higher than the prices of conventional products), Nabi et al., 2017, and Jat et al., 2018, reported a significant increase in yields and nutritional characteristics in biodynamics compared to organically and conventionally grown vegetables, respectively cereals. Also, Jakop et al., 2017, found that the production of pumpkin seed oil (*Cucurbita pepo*) in the biodynamic system could compete with that obtained in the conventional production. Maneva et al. 2017, by comparing the yield of organically grown wheat (*Triticum turgidum* subsp. *Polonicum* L.) with biodynamically grown wheat observed significantly higher yields in biodynamic processing. In Germany a study conducted by Reinken et al., 1984, reported that all vegetable crop yields obtained for a period of six years were lower on biodynamic plots compared to conventional plots. Prices for biodynamic products were however higher, leading to higher

profits for most biodynamic vegetables. Economic studies have shown that biodynamic agricultural systems could achieve a profitability close to that of conventional or organic farms (Holmes, 1993). By examining 28 different experiments in Germany it was revealed that the use of biodynamic sprays increased crop yields in years when yields were low (Raupp & König,

1996). Schlüter, 1985 analyzed the yields and profitability of 16 biodynamic farms in seven regions of Baden Württemberg and compared the results with statistics from the German Ministry of Agriculture. He concluded that the yields of all cereal crops grown on biodynamic farms were lower. Milk productivity on biodynamic farms was almost 15% lower compared to conventional farms. However, because biodynamic farms had lower costs than conventional ones, their profit was higher (Koeopf, 1986). Lampkin & Padel, 1994, 1994b have recorded similar results in terms of the economic performance of biodynamic farms.

CONCLUSIONS

The study regarding farmer's opinion from the Transylvanian Plain and Plateau by examining the way they perceive the concept of biodynamic agriculture represents an original contribution of the present paper, which enriches the specialized literature. Although our sample is limited and the number of respondents who know or are willing to convert to this type of agriculture is low, we believe that providing more information about the potential and benefits of this type of agriculture could increase the number of biodynamic farms in the studied area. This conclusion is also reinforced by the claims related to the superior quality of these products. Also, the results obtained in this research show that respondents believe that there may be profitability and the market as a result of consumer preferences for healthy products even in conditions of a higher price of the product.

Under the present and future scenario of climate change and consumer preference for ecological food, it is imperative to explore research on biodynamic agriculture.

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