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Biodynamic Farming – Method for Sustainable Production of Quality Food

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Summary

Biodynamic agriculture is an organic farming method that could provide ecological, economical and physical sustainability. Biodynamic agriculture was a subject of research during the past decades although part of the scientific community looks at the method with skepticism. In the past 30 years there have been published results of experiments as well as case studies that show the effects of biodynamic preparations on yield, soil quality and biodiversity. The case studies presented a positive environmental impact in terms of energy use and efficiency.

The concept of biodynamic agriculture is gaining popularity because of the rising challenges coming from climate change, resource scarcity and population growth. Such alternative practices are viable methods that could make farming systems more diverse and sustainable.

The aim of the paper is to underline the basic definitions and history of biodynamic farming, describe the main features of this method and to present different studies and case trails comparing biodynamic, organic and conventional agriculture.

An overview of different long term trails on biodynamic farming is done. The results show that these systems generally have better soil and product quality and equal or greater net returns per hectare than conventional farms.

Key words: biodynamic farming, preparations, sustainability, yield

Биодинамичното фермерство – метод за устойчиво производство на качествена храна

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Резюме

Биодинамичното земеделие е метод за органично земеделие, който може да предостави екологична, икономическа и физическа устойчивост. Биодинамичното земеделие е обект на изследвания и през миналите десетилетия, въпреки че част от научната общност гледа на този метод със скептицизъм. В последните 30 години има публикувани резултати от експерименти, както и задълбочени изследвания, които показват положителния ефект върху околната среда по отношение на ефективността на използване на енергията.

Биодинамичното земеделие като понятие печели популярност поради растящите предизвикателства, свързани с климатичните промени, оскъдните ресурси и увеличаването на населението. Такива алтернативни практики могат да направят фермерските системи по-разнообразни и по-устойчиви.

Целта на настоящия доклад е да представи основните дефиниции и историята на биодинамичното фермерство, да подчертае основните характеристики на този метод и да представи различни проучвания, сравняващи биодинамичното и конвенционалното земеделие.

Ключови думи: биодинамично фермерство, подготовки, устойчивост, добив

Introduction

The environmental and economic problems associated with conventional agriculture are serious issues. The inefficient trends in the industrial organic practices provoked the movement towards biodynamic agriculture. The nature of organic has changed from farming concerned about environmental and social implications to one focused on globalization. The biodynamic farming systems are more about ecology, quality of food, human health, landscape etc.

The aim of the paper is to underline the basic definitions and history of biodynamic farming, describe the main features of this method and to present different studies and case trails comparing biodynamic, organic and conventional agriculture.

In the first part the paper outlines the basics of biodynamic farming and short history of the movement. The second part focuses on the unique preparations and the other main principles and practices. In the third part, some case trails and economic benefits of biodynamic farming are investigated and analyzed.

Definitions

Biodynamic agriculture as one of the organic farming methods could provide ecological, economical and physical sustainability. "It includes many of the ideas of organic farming, and at the core focus are mystical anthroposophical ideas of the soil and the life on and in it as a living, sentient system." (Phillips, 2006). Biodynamic agriculture is considered as an alternative farming system which main principles are to respect all creations. According to (Diver, 1999) a basic ecological principle of biodynamic agriculture is to conceive of the farm as an organism, a self-contained entity. The farm is said to have its own individuality. Emphasis is placed on the integration of crops and livestock, recycling of nutrients, maintenance of soil, and the health and wellbeing of crops and animals; the farmer too is part of the whole."

History

The development of biodynamic agriculture began in 1924 with a series of lectures by philosopher Rudolf Steiner at Schloss Koberwitz, Germany (now in Poland). From these series of lectures are emerged the fundamental principles of biodynamic farming and gardening. Ehrenfried Pfeiffer, who worked with Steiner, brought and developed biodynamic concepts and ideas to the United States in the 1930s.

Unlike "organic farming", which appeared fully formed in *Look to the Land* and within a coherent manifesto (Paull, 2006), "bio-dynamic farming" evolved over 14 years. Although Rudolf Steiner is the "originator" of bio-dynamic agriculture (Pfeiffer, 1938), the term 'bio-dynamic' have been entirely unfamiliar to him. The first English translation of Rudolf Steiner's *Agriculture Course of 1924* included the phrase: "the biological-dynamic methods" (Wachsmuth, 1989). Two pamphlets authored by Pfeiffer in the paper. "The Biological-Dynamic Method of Rudolf Steiner" reflects the term "biological-dynamic" (1924a, 1924b). After a decade of use "biological-dynamic" was contracted to "bio-dynamic", with this new contraction appearing in Pfeiffer's 1938 publications: *Practical Guide to the Use of the Bio-Dynamic Preparations and Bio-dynamic Farming and Gardening*.

Steiner insisted that the methods proposed in his lectures should be tested experimentally. For this purpose has been established a research group – *Agricultural Experimental Circle of Anthroposophical Farmers*. This group included about 800 members and existed in the period of 1924–1939.

The German agronomist Erhard Bartsch created another group – "Association for Research in Anthroposophical Agriculture". The main objective was to test the effects of biodynamic methods on soil, plants and animal. Bartsch established a sales organisation for biodynamic products, *Demeter*, which still exists today. In 1928 the *Demeter* symbol and first Standard was introduced. The *Farm Standard* is historically very

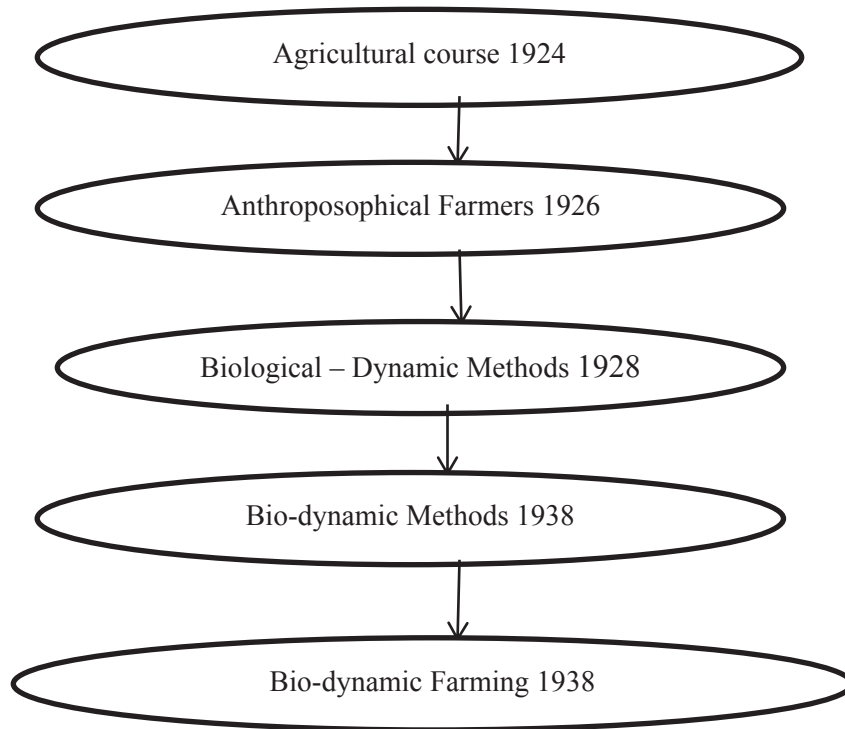


Fig. 1. Evolution from Agriculture Course to Bio-Dynamic Farming
Source: Based on Paull (2011).

important because it dates back to the beginning of the modern sustainable farming.

In 1938, Ehrenfried Pfeiffer's book *Bio-Dynamic Farming and Gardening* was published in five languages, included and formed the biodynamic farming basic principles for several decades.

In 1985 Demeter was formed in the US as a non-profit organisation, seventeen years before the establishment of the National Organic Program. Demeter International is the first, and remains, the only association consisting of a network of individual certification organizations in 45 countries around the world.

Biodynamic agriculture plays an important role in the alternative agriculture. At present, approximately 8,000 biodynamic farms in fifty-three countries are certified by Demeter International (Demeter International).

Biodynamic main principles

The main feature of the biodynamic farming according Steiner is the relationship between the

pedosphere, ecosphere and atmosphere in order to achieve sustainable development of the holdings. The farm is living organism and the crops and livestock are deeply connected with surrounding ecosystems. Central principles of biodynamic farming include crop diversification, the avoidance of chemical soil treatments, decentralized production and distribution, and the consideration of celestial and terrestrial influences on biological organisms. Biodynamic farming methods recommend the individual design of the land "by the farmer, as determined by site conditions, is one of the basic tenets of biodynamic agriculture. This principle emphasizes that humans have a responsibility for the development of their ecological and social environment which goes beyond economic aims and the principles of descriptive ecology" (Leiber, F. et al, 2006).

The main purpose of biodynamic agriculture is to maintain sustainable system and biodiversity that contribute to soil health. The crop rotation is fundamental for biodynamic farming. The use of cover crops and intentional crop plantings enable farmers to fix nitrogen as well

as incorporate additional nutrients into the soil without industrial fertilizers (Leiber et al. 2006). The animal manure is basic component of composting process and important feature of biodynamic agriculture. These methods are element of organic farming and not only for biodynamic agriculture.

Biodynamic livestock is based on specific belief the animals have souls and should be treated respectfully. The biodynamic livestock has a lot of unique features and most of the practices are perfect example of Steiner's views. Some of them include the prohibition of both dehorning and isolated breeding because of the cruel and inhumane implications (Baars and Spengler, 2003). According to biodynamic farming principles the main aim of the farm should not be the maximum yield, but the wellbeing of the animals.

The other basic feature of biodynamic farming is the unique preparations. The biggest difference between biodynamic agriculture and organic farming are Steiner's special preparations. Steiner's fertilization methodology also uses processes that reflect mystical and superstitious elements (Conkin, 2008). Steiner revealed nine different preparations for fertilizers and detailing how to be prepared. The substances used for preparing fields and making compost are numbered 500 through 508. Biodynamic farms should use these medicinal, herbal and mineral preparations in small quantities.

Although the preparations have direct nutrient values, their purpose in biodynamics is to support the self-regulating capacities of the soil biota in the case of 500 and 501 and the biological life resident in the composting organics, as well as the mature compost itself, in the others. (Raupp, 1996)

The first two preparations are field preparations that stimulating humus formation:

- 500: (horn-manure) humus mixture prepared by filling the horn of a cow with cow manure and burying it in the ground in autumn;
- 501: Crushed powdered quartz prepared by stuffing it into a horn of a cow and buried into the ground in spring and taken out in autumn. It can be mixed with 500 but usually prepared on its own.

The next six preparations – 502–507 are used in making compost (Proctor, 1997):

- 502 Yarrow blossoms (*Achillea millefolium*);
- 503 Chamomile blossoms (*Chamomilla officinalis*);
- 504 Stinging nettle (whole plant in full bloom) (*Urtica dioica*);
- 505 Oak bark (*Quercus robur*);
- 506 Dandelion flowers (*Taraxacum officinale*);
- 507 Valerian flowers (*Valeriana officinalis*).

Finally, there is preparation 508 which is prepared from the silica-rich horsetail plant and used as a foliar spray to suppress fungal diseases in plants.

Compared to non-organic agriculture, biodynamic farming practices have been found to be more resilient to environmental challenges, to foster a diverse biosphere, and to be more energy efficient, factors. Eric Lichtfouse describes being of increasing importance in the face of climate change, energy scarcity and population growth (Padmavathy and Poyyamoli, 2011).

Another important principle of biodynamic agriculture is an emphasis on celestial and astrological patterns. Steiner reveals the importance of this concept in his lectures: "we shall never understand plant life unless we bear in mind that everything which happens on the Earth is a reflection of what is taking place in the Cosmos" (Steiner, 1924a).

The cosmic cycle as a main feature of biodynamic make this method much different from many forms of agriculture because this mystical and astrological orientation.

In the Beginning of 1950s Maria Thun decided to test Steiner's principles in her farm in Darmstadt in Germany, beginning with radishes. Planting the vegetables when the moon was in different constellations, she discovered that they glowed into different forms and sizes. Over years of research she concluded some of her main principles. According to Thun different crops grow better relative to the moon cycle.

In 1962, she created a series of annual planting calendars and later set out the principles of her methods in *Gardening for Life: the Biody-*

namic Way. In 2010, with her son Matthias, she published *When Wine Tastes Best: A Biodynamic Calendar for Wine Drinkers*.

The approach considers that there are lunar and astrological influences on soil and plant development for example, choosing to plant, cultivate or harvest various crops based on both the phase of the moon and the zodiacal constellation the moon is passing through, and also depending on different crop types. The basis of the whole Maria Thun system is the Moon. A moon cycle is completed in about 28 days. Average moon passes through a constellation of about two and a half days, but there are major differences.

In the system of Maria Thun the crops were divided into four groups. The first covers all fruits and cereals. The second is the root plants – carrots, potatoes, but the issue is whether they are actually roots or seeds. Third is the group of leaf plants - cabbage, rhubarb, lettuce, sorrel. Fourth

is the group of blossom plants – broccoli, cauliflower and artichokes.

The next important feature is the zodiacal constellations. Each constellation is one of a trine of three similar constellations. Each trine is assigned a classical element. Warmth/fire (Aries, Leo and Sagittarius) affect positively fruit and cereal. If the Moon passes through some of them – this is the good time for planting, offsetting and harvesting. Earth constellations (Taurus, Virgo or Capricorn) have positive influence on root crops. Water signs (Scorpio, Pisces and Cancer) on leaf plants and air/light constellations (Libra, Aquarius and Gemini) on blossom plants.

Another important factor is whether the moon is ascending or descending. This factor has nothing to do with moon phases. During its movement in half of the way moon moves to its highest position – this is the ascending moon. Descending moon is when it goes to its lowest position. While

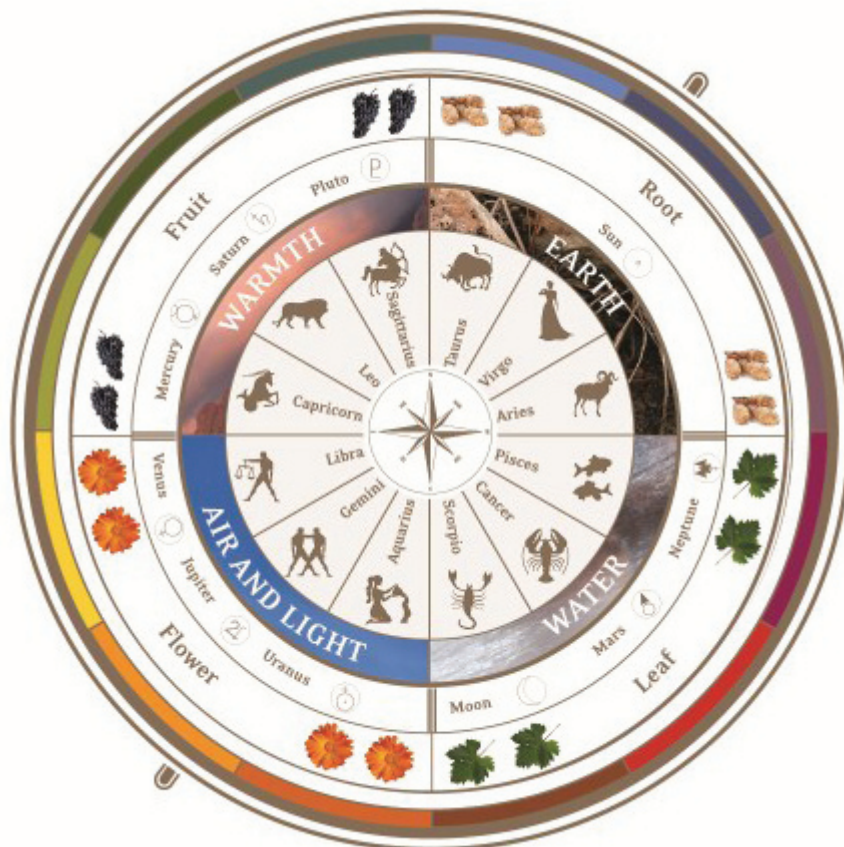


Fig. 2. Maria Thun biodynamic calendar
 Source: Thun, M., *Gardening of life*.

the moon is “down”, it is the appropriate time to plant and care for plants, and when takes back up, it is time for harvesting. The first phase is good for cutting, and the second – for grafting.

Out of those mystical and spiritual elements biodynamic farming has its followers and is gaining interest in the scientific world.

Biodynamic farming- case studies

The researches on biodynamic farming systems are scarce in contrast to organic farming systems. Although there have been many articles describing studies of biodynamic practices, most of this information has not been reviewed by soil scientists, agronomists, agricultural economists (Koepf, 1993). Several significant studies examining biodynamic farming methods or comparing biodynamic with other farming systems have been published in the referenced scientific literature, especially in English. Most of these studies have been conducted in Germany and Sweden and are not available in English.

Besides published results of short-term trials, several long-term trials have been effected with the inclusion of the biodynamic farming method and/or biodynamic preparations. Table 1 shows a brief description of long term case studies conducted in Europe.

The experiments in Germany (Raupp, 1995), and Switzerland (Berner et al., 2008) and one 32-year old experiment in Sweden (Pettersson, 1992)

compared conventional, organic, and biodynamic methods. In general, the alternative systems showed enhanced soil quality and lower production than conventional management. The biodynamic soils in all three experiments had better quantities of soil organic matter and greater soil enzyme activity than the organic system. Examination of 28 different experiments in Germany showed that the use of the biodynamic sprays increased crop yields on years where yields were low (Raupp and Koenig, 1996). This so called “yield-balancing” effect could possibly be important for reducing risk for farmers, and it may be caused by enhanced soil quality and rooting. These regulators have been shown to have hormone-like effects on various crops grown in several studies (Goldstein, 1979; Goldstein and Koepf, 1982; Fritz et al., 1997).

In Bulgaria biodynamic agriculture is not popular. In 2013 the Institute of Agriculture in Karnobat has formed a non-certified experimental biodynamic field of 2 hectares, growing cereals after pea as predecessor. Phytosanitary monitoring was conducted and the soil conditions and plant development were reported. The results were compared with cereals grown under organic and conventional farming conditions. The study is expected to gather more information in the coming years and take into account the long-term effects on soil and plants in order to present official data (Maneva et al., 2014).

Table 1. Long-term trials, based on scientific methods and include biodynamic research

Country of trial	Trial description	Duration of trial
Therwil, Switzerland	biodynamic, organic, conventional farmyard manure and conventional-mineral farming systems are compared with control plots	1978 – present
Darmstadt, Germany	Competition between mineral and organic fertilizers	1980 – the present
Bonn, Germany	Effects of traditionally composted farmyard manure against two types of biodynamic composted and a control plot were investigated	1993–2001
Marburg, Germany	28 different experiments on effect of biodynamic sprays on yields	1990–1995
Sweden	Study the effects of biodynamic, organic, and conventional management on soil and crop quality	1958–1989

Source: Based on Turinek (2009).

Some other Bulgarian authors have researched the main features of biodynamic farming (Vlahova and Arabska, 2015a) and the specific preparations (Vlahova and Arabska, 2015b). The studies on biodynamic farming systems in Bulgaria are scarce. Although the movement is progressing the information and research results are insufficient to formulate any conclusions and recommendations.

Economic studies

Some other short term studies and trials are conducted by using gross margin as a measure of economic performance. Schlüter (1985) analyzed farm labor, yields, and profitability of 16 biodynamic farms. Results from the biodynamic farms were compared with annual official statistics from the Ministry of Food, Agriculture and Environment for conventional farms in each production region. The yields of all the cereal crops on biodynamic farms were lower and the average were almost equal to conventional farm yields on the good soils and considerably lower on the poorer soils. Potato yields were similar in the two farming systems. Milk yields per cow on biodynamic farms were almost 15% lower than on the conventional farms. The biodynamic and conventional farms had similar gross revenues. Gross revenues per hectare from all crops were higher on the biodynamic farms, whereas gross revenues from animal husbandry (beef, pork, milk and eggs) were lower on the biodynamic farms (Koepf, 1986). However, because the biodynamic farmers had lower costs than the conventional farmers, their profits were higher.

Research on biodynamic and conventional farming systems began in 1979 on a 72 – ha experimental farm in Nagele, Netherlands (Verijken, 1990). Economic data indicated that gross revenue was the highest for the biodynamic farm because of the high premiums paid for the biodynamic products. The total production costs also were higher for the biodynamic farm than the conventional or the integrated farm and the biodynamic farm had the lowest net income. According to (Lampkin, 1990) a less labor intensive organic system could have been developed

that would have been more competitive given the conditions in the region.

On research plots at an experiment station in German, yields of all vegetable crops for a six-year period averaged less on biodynamic plots than on conventional plots (Reinken, 1986). However, since the prices received were higher for biodynamic than for conventional vegetables, profits were significantly higher for most biodynamic vegetables.

Reganold et al. (1993) compared the economic performance of biodynamic and conventional farms in the same study that analyzed soil quality. The study examined annual accounts from 1987 to 1991. These results were compared to conventional farm data in annual reports by the Ministry of Agriculture and Fisheries in New Zealand. The biodynamic farms were as profitable as the conventional farms. Most of their products were sold as certified organic or biodynamic at premium prices up to 25% above the market prices of similar conventional products. Most of the biodynamic farms had less year-to-year variability in gross revenue than the conventional farms (Reganold et al., 1993).

The main targets of biodynamic farms are protection and enhancement of soil in order to produce high quality products. This paper summarizes the most significant studies that compared soil quality or farm profitability in biodynamic and conventional farming systems. These studies found that the biodynamic farming systems generally had better soil quality, lower crop yields, and equal or greater net returns per hectare than conventional farms. The economic studies showed that biodynamic farming systems could be profitable and could exist in long-term. Many biodynamic farmers stay in business because of the price premium received for their products. Although the studies included these premiums, they did not count the environmental and health costs, which are external to the farm's accounts. Indirect costs such as damage from soil erosion, surface and ground water pollution, hazards to human and animal health, and damage to wildlife from conventional farming practices are presently borne by society. When these external costs are included in the costs of production, the profit-

ability and benefits to society have been shown to be the greater for some alternative farming systems (Holmes, 1993).

Conclusions

Biodynamic farming is important and alternative method that could provide more sustainable farming system. Biodynamic agriculture originally consisted of a mystical and unscientific, alternative approach to agriculture. The testing of biodynamic preparations is limited and the evidence that addition of these preparations improves plant or soil quality is still in debate. The scientific word however should be open for more holistic approach because biodynamic has the potential to restore soil integrity and farmer communities, while producing sustainable, healthy food.

The case studies conducted in different countries showed the ability of biodynamic agriculture to function as an alternative to the conventional forms. The biodynamic holdings could be as profitable as the conventional farms. Therefore it is necessary to do a further research and development of this alternative method, particularly in relation to pressing environmental problems in recent decades.

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