

Biodynamic Farming - Path for Sustainable Ecosystem

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Abstract: *Biodynamic farming and objective farming both are similar as they are ecologically oriented and don't use chemical fertilizers. The basic difference is that biodynamic farmers add eight specific amendments that are referred as preparation to their soil, crops and composting. The objective of this paper was to assess how biodynamic farming will lead to the sustainability as sustainability is all about surviving for the long term. To investigate the effect of preparation on soil quality, food quality, human health and their well being. Biodynamic farming is ecofriendly as there is no production of waste as, everything that is been called waste is been recycled to other parts of the farm hence no adverse effect on environment. Hence proving "environment sustainability". Overall, biodynamic farms have the potential to be self-sufficient. Their biggest hurdle is to be economically sustainable, as they mainly operate as a charity. There is always the chance that the farm can run at a loss due to the withdrawals of third party funding or sponsorship. Socially sustainable communities are diverse, connected and democratic and provide a good quality of life. Therefore in terms of social and environmental sustainability biodynamic is sustainable. A biodynamic farm is working on each of these principles in it day to day running, therefore making it feasibly sustainable.*

1. Introduction

Biodynamic is a combination of two words "biological dynamic" agriculture practices. "Biological" practices include various technique of organic farming that improve soil health whereas "dynamic" practices helps in influencing biological as well as metaphysical aspects of the farm such as increasing vital life force or to adapt the farm to natural rhythms. Biodynamic was the first modern organic agriculture. Its development began in 1924 by philosopher Rudolf Steiner at Schloss Koberwitz with a series of eight lectures on agriculture (Steiner 1925, c. f. Pauce 2011). The impact of damage caused by agriculture has led to the need for sustainable farming system so that it can help in increasing the movement to protect wildlife, to prevent land degradation and also in decreasing environmental harm caused by farming practices (European commission 2006). More than 5, 500 farmers practice biodynamic farming worldwide (Demeter International, 2019) and the farming methods have a very good reputation among consumers of organic products.

The main aspect of developing this is to tackle the growing problem of soil erosion that was occurring at the time. Biodynamic farming disallows the use of chemical pesticides and fertilisers they aspire to generate their own fertility through composting, integrating animals, cover cropping and crop rotation. Biodynamic plants are grown in the ground in living soil which provides a quality of health and nutrition which is not possible with chemical fertilizers. It not only helps in soil fertility but also plays a vital role in pest management. The natural substances that are present in farm itself are used in the preparation of fertilizers, sprays and manures instead of using chemical substances. It allows less use of outside input and leads in creating closed systems as all the inputs are from within the farm itself. (Carpenter Boggs, 2011). Factors like understanding the habitats of the pest, time of cropping and extent of penetration of sunlight

into the farm helps the biodynamic farmers to control the pests naturally.

In addition with classical natural science methods, researchers were always interested in developing new analytical approaches in biodynamic farming. Biocrystallization is an example of new analytical method that has gained its reputation in scientific literature (Fritz et al.2011) Studies provide substantial evidence for positive effect of biodynamic farming for sustainable ecosystem. It is believed that in biodynamic farming the harmonization and restoration of the farms life forces are reinforced to enhance the quality, flavor and nutrition of the farms produce (Mason.2003). The value of food can be improved with the nutritive properties and taste through biodynamic production. The biodynamic management improves grape quality and plant traits compared to non-biodynamic management.

2. History

Agriculture plays an important role in human life. We grow food to eat, for maintaining our bodies, our minds, our soul and our spirit. But from the past few years we are losing our connection to our source of life. Use of chemical farming is the other name of world war. Fossil fuel is the source of chemical from the earth which is not sustainable and will not be available in future. In 1960^s and 1970^s Green revolution introduced hybrid seed it create dependency on the hybrid seed companies for the farmer because these seeds do not developed its own seed once grown. These seeds require higher dose of pesticides and fertilizers as they produce weaker plants. Genetically modified crops which are been recently introduced is a threat to earth as well as for human beings. Due to its great economic interest it create pressure on the developing countries to accept the use of these seeds.

Chemical farming is affecting the health of human beings and also economic life of the farmer. Because of the

abundant use of chemical fertilizers the soil is becoming hard. Due to the heavy use of chemical fertilizers new pest and diseases raised that become resistant to chemical pesticides. Because of all these destruction biodynamic method of agriculture started that slowly and gradually become popular in the last few decades all over the world. There are Biodynamic association of farmers and gardeners and certifying bodies that guarantee the produce being sold by issuing a Demeter certificate.

Biodynamic Preparations

To differentiate biodynamic approach from organic approach one of the most specific feature or important element is biodynamic preparation. Crop rotation, composting, organic method of farming are some of the practices shared by biodynamic agriculture. (Diver, 1999). However the main feature of biodynamic agriculture is to work with the environment with the use of method of preparation that are been applied to soil, crops and compost (Reeve et al, 2010). The preparation comprises of specific minerals and plants which are been treated water, soil and animal organ (Stenier, 1974). According to the specific planting calendar preparation are been applied in the form of sprays and manures. The calendar consists of lunar, cosmic cycles and season that increases the capability of growing crops in relation with planting and spraying. (Thun, 2015)

(Sharma et. al (2012) found out that by applying horn manure and horn silica fertilizer there was more than 30% enhancement in the production of cumen seed. There was also an increasment in the yield of two different varieties of soyabean by 30% because of the application of biodynamic preparation (Tung and Ferandez 2007). Another example is of two rice varieties whose yield was been increased by 15% to 20% due to the application of biodynamic preparation without the use of fertilizer (Valdez and Fernandez 2008). Due to the application of biodynamic preparation there was a sudden increase in the dehydrogenase activity in compost (Reeve et. al.2010)

The yield of black gram was been increased by 27% that was cultivated under organic condition without the use of fertilizer due to the application of horn silica when compared with the treatment in which horn silica was not present (Trivedi et. al.2013). By the application of horn manure and horn silica in three pumpkin varieties and in three potato varieties their net photosynthesis activity was been increased (Jukneviene 2015, Vaitkeviciene 2016). Bacterial culture has auxin present in it that has been identified in horn silica that helps in the enhancement of growth in corn (Radha and Rao 2014). Activity of nitrogen, urea, phosphorus, potassium and sucrose is been increased in the soil from past three years by using horn manure treatment during the cultivation of pumpkin and potato (Jukneviene 2015, Vuilkeviciene 2016 et. al).

It is been seen that the compost develops faster with less loss of nitrogen, have fewer odour problem and has greater nutrient holding capacity that is been produced by the method of preparation. (Klett, 2006). In terms of energy use and efficiency preparation have positive impact on the environment. (Turinek, 2009) From the research it is been cleared that biodynamic farm makes the soil quality better and greater than that of conventional farm because of

preparation used in it. It have been found that the soil from biodynamic farming have greater physical and biological quality as well as rich in organic matter content.

Effects of biodynamic preparation on soil quality

Researches have found that the state which have preparation has a great effect on the soil and in some state there was not quit difference between soil treated with preparation. So this is unclear whether biodynamic preparation effect the soil or not. (Reeve et al., 2010) The answer will be given in four peer reviewed research articles. The first article investigated was on the effects of preparations on compost over 13 month's trial. (Carpenter-Boggs et al., 2000 a). It was proven that compost treated by preparation have greater quality when compared with untreated one. It also found that the compost treated by biodynamic preparation contain 10% less CO₂ and high ratio of dehydrogenase enzyme to CO₂ production. More CO₂ results in the complete decomposition of compost. The compost have high temperature due to the activity of microbiological organisms that helps in controlling the weeds and pathogen as well as lead to faster decomposition. This also suggests that the compost contain higher amount of nitrogen (N₂) that allow complete decomposition to occur. From this study we found out the difference between treated and untreated compost and clearly depict that quality of biodynamically treated compost is high.

Second study was conducted by carpenter-Boggs et al., (2000 b) who investigated on the effects of preparations over the course of two years. Treated soil and untreated soil was not having any difference, the only difference that was found out was the presence of fatty acid in the treated soil in the first year however that was also considered negligible. So this is the reason why it is unclear or the researcher don't have the answer on the effect of biodynamic preparation on the soil.

The third study was been conducted by Reganald et al., (1993). He find out the effect of preparations on soil over two biodynamic farms. Soil of two conventional farms was been compared and some differences were been recognized. The soil which was been treated by preparation has better structure and easily broke down to seedbed. Crops and growth of grass was better in treated soil due to good drainage and aeration. The bulk density of the soil was also low when compared to conventional soil. This makes the movement of roots easy and to grow through which is a benefit for the crops. It was also noticed that the treated soil have high organic matter and materialized nitrogen content that results in more nutrients for the crops with more growing potential. (Lewandowski, 2002). Despite all these difference Reganald et al., suggested that there was no difference in soil below 20cm from the surface.

The final study was been examined by Reeve et al., (2010). The result was that the treated soil has high dehydrogenises enzyme activity. This was due to the presence of microbiological content which lead to decomposition at high rate. Therefore all the four studies suggested that the biodynamic preparation has some effect on the soil quality which include increase organic matter content, high dehydrogenises activity and high decomposition rate.

Soil Quality and Soil Health

To improve the soil and quality of crop preparation method were been developed. Six preparations were applied to the compost pills and three more preparations were applied directly to soil or crops as field sprays. The main aim was not to add nutrients but to enhance the process of nutrients and energy cycling. Soil quality mainly refers to the ability of producing good yields with good quality crops and to protect the health of human and animal without disturbing or harming the natural resources. In scientific literature very few studies have discussed about the issues related to the soil in biodynamic farming. (Turinek et al 2099, Ponzia et al.2013) The focuses of these studies are on the effects of biodynamic management on soil organic matter, soil biology, availability of nutrients. DOC experiment set a comparison between fertilization and crop protection on the basis of continues crop rotation. (Description in Fliebach et al.2007). The second experiment at Darmstadt compared biodynamic management with organic management and also with non-organic treatment. The aim was to use the application of N-fertilizer with the application of organic manure. (Rauupp and Oltmanns 2006). The third experiment was of Frick that is a three factorial experiment where different levels of fertilization and tillage intensity was been compared with the effect of biodynamic management (Bernier et al.2008).

Soil organic matter (SOM) is a vital factor of soil fertility and of many soil functions. DOC experiment has been demonstrated the level of higher SOM under biodynamic management that is been compared with all non-biodynamic treatments (Flieback et al.2007). According to Heitkamp et al.2011), SOM level under biodynamic management was also higher when compared to non biodynamic management. In Frick experiment there was no difference found in the SOM levels of both biodynamic and non-biodynamic management. (Gadrmaier et al.2012). In the DOC experiment biodynamic management led to a higher availability of stable organic matter ratio (Birkhofer et al.2007), increased biological activity, a change in the population of bacteria (Heger et al.2012) and a better consumption of carbon by the microbial biomass (Flieback et al.2007) as compared with non-biodynamic treatments. Therefore from the results of Darmstadt and Frick experiment it proved that biodynamic preparation has positive effect soil biological properties and processes. Further, Radha and Rao (2014) aspects that both the population of bacterial and fungal can increase the availability of phosphorus to plants through biodynamic preparation.

Food Quality

Biodynamic Food	References
When compared with organic and conventional system he observed that in Batavia lettuce the content of polyphenol act as an nutritional additive in the food products	Heimler et al.2011
The concentration of total phenolic compound and antioxidant activity drastically increased in potatoes after the application of biodynamic preparation horn silica	Jariene et al.2017
The content of phenolic and anthocyanins	Jariene et al.2015

increased in coloured flesh potoes because of the application of integrated biodynamic preparation with horn manure and horn silica	
From the past three years of higher amount of antioxidant of lutein, lyopene and xanthin were found in three varities of pumpkin when treated with horn manure and horn silica treatment	Jukneviene, 2015
When compared with conventional and organic farming system higher antioxidant activity were been found in biodynamic red beet, biodynamic strawberries and in mature green and ripe mangoes	Bavec et al.2010., Fragaria spec., D' Evoli et al.2010., Maciel et al.2011
More ascorbic acid was found in biodynamic cabbage than organic or conventional cabbage	Bavec et al.2012
Biodynamically produced red beets showed highest sugar content when compared with other system	Bavec et al.2010
Potatoes from biodynamic cultivation shows positive traits such as quality indices, dry matter content, taste quality, pure protein and biocrystallization value	Kjellenberg and Granstedt 2015
He observed that biodynamically prepared milk has highest nutritionally valuable fatty acid	Kusche et al.2015
Mothers of new born babies who consume biodynamically prepared dairy products has lower risk of contracting eczema	Thijis et al.2011

How Biodynamic Farming will Lead to Sustainability

Sustainability can be achieved by surviving for long term. The desire of sustainability can only be fulfilled by developing technologies that wont deplete the natural resources and don't have negative impact on environment (Pretty, 2008). Turinek et al.2010 and bavec et al.2010 showed that from the past three years biodynamic and organic system rule over conventional when compared with environmental performance and ecological effectiveness related to impact on the climate and use of the energy. In Italy, after the assessment of lifecycle and analysis of energy in integrated and biodynamic apricot or charoes, it as been proved that these have lower impact on environment and also lower the demand for energy (Pergala et al.2016). Sustainability an only be achieved through three pillar and to be self-sufficient.

Environmental sustainability: It should not have any adverse effects on the environment, should maintain and protect the earth's natural resources for future to be environmentally sustainable. (Tilman et al., 2002). Biodynamic agriculture does not produce any waste products because the waste is been transferred from one part to another and leads in increasing the capacity of self-renewal (Demeter Association, INC, 2014). By not using the chemical fertilizer it saves earth from the negative effects. Biodynamic farming prevents soil erosion and soil pollution (Peigne and Girardin, 2004). Even by modern agricultural standards biodynamic is one of the most feasibly sustainable options.

Economic sustainability: From the point of business, biodynamic farm can be economically sustainable as well as unsustainable. This is due to the fact that everybody is not able to pay for certified biodynamic food or they don't want to eat biodynamic food. Biodynamically produced food is

more expensive than the conventional way. Loch Arthur farm shop supplied a price list from organic North for the month of march 2015. The data depicts that biodynamically produced food crops are more expensive per kg than conventionally farmed products. But in contrast biodynamic food are becoming socially acceptable as it is healthier and can be traced back to the farm it was grown on. People have become aware of food borne hazards from pesticides, hormone treatments and artificial ingredients.

Social sustainability: In a social standing, biodynamic agriculture encompasses the main principles of social equity, cultural diversity and acceptance of everyone (Hodgson, 2009). It has been observed that people quality of life can be improved by living in socially and active way (Fisher and Li, 2004). The aim should be to help people in developing their character, improving their life skills, enable safe learning and working environment. The farms and shops are used as a way to being the community together by providing a social and working environment. Thus biodynamic farm is indeed run in accordance to social sustainability.

Biodynamic Principles and Practices

Biodynamics cultivates biodiversity: Biodynamic farms and gardens are inspired by the biodiversity of natural ecosystems and the uniqueness of each landscape, flowers, berries, herbs, fruits, forage, grains, pasture, annual and perennial vegetables and pollinator these all help in diversify plants and amplify the health of the farm organism. Various animal species bring different connection to the land and distinctive quality of manure that diversity is beneficial for domestic animals. Starting with few primary crops and one or two species of animals and by adding more species as the farm organism matures in this way diversity of plants and animal's life can be developed over time.

Biodynamics generates on-farm fertility: Chemical fertilizers cannot provide that much amount of health and nutrition which is been provided by biodynamic plants because they are grown in the living soil of the ground. By cover cropping, crop rotation, integrating animals and through composting, it generates its own fertility for the farm organism. For the proper circulation of nutrient cycle and for providing manure and nurture to the soil, integrating the diversity of animals plays a vital role in it. Cover crops bring life and sensitivity to the soil by providing oxygen and nutrition. Crop rotation helps in balancing the need of each crop and enables a diversity of creative expression in the soil. Because of these practices the need of importing fertilizers are been reduced and push the farm to move towards equilibrium and flexibility.

Compost is enlivened with biodynamic preparations: Biodynamic compost is enhanced and enlivened through the use of six preparations made from yarrow, chamomile, stinging nettle, oak bark, bandelion, and valerian each of these medicinal herbs is converted by a distinctive activity that brings connection with the animal kingdom, the earth and the cycle of the year. Combining these elements help in healing qualities, fosters the growth of beneficial bacteria and fungi, and for the development of compost generates powerfully concentrated substances. Biodynamic preparation strengthen the quality of compost by stabilizing

nitrogen (Carpenter-Boggs, L., Reganold, J. P., Kennedy, A. C.2000) and other nutrients multiplying microbial diversity and brings more sensitivity to the composing process. Biodynamic compost helps to accommodate the soil, increasing the life of soil and making the organic matter stable. (Zaller, J. G., Kopke, U.2004). Biodynamic compost helps in restoring the balance of the climate and produces more carbon into the living kingdom.

Biodynamics supports integrity and diversity in seeds and breeds: Biodynamic farmers and gardeners favor heirloom, open-pollinated and non-GMO seeds and animals it incorporate selection and breeding into the farm activities with very good nutrition and opposition to pest and diseases. On the other hand of biodynamics earthly and cosmic influences are considered in developing plants and animals that can survive in present condition and leads to the health of farm and community.

Biodynamics approaches pest and diseases holistically: Biodynamics aims at making conditions that is optimum for soil, plant and animal health and for providing nutrition in balanced amount and supporting healthy immunity. Pest and diseases have few places to survive because of the habitat created by robust diversity of plants and animals. It often create imbalance in the farm organism when there is a presence of disease. When an outbreak occurs biodynamic farmer finds out its way to prevent the imbalance and adjust management practices to ring the farm organism to greater health.

3. Challenges or Limitation of Biodynamic Farming

Major challenge for biodynamic agriculture according to WUR (Van Doorn et al., 2016) is, it need its own training and quality mark, should have strong spiritual side and caters to a niche market. Because of the fact that there is a long-standing certification for biodynamic farm and products as it is helpful for providing approach with market. But on the other side it has small niche market as well as the obscure, spiritual element differentiate this approach from others. Because of this only many people put off who might be otherwise sympathetic. 500 Demeter make for a critical mass. In Europe the certification is not widespread as EU in 2016 counted nearly 250000 organic certified farms within the EU (DG AGRI, 2019). Because of labels have arrived in the market which leads to several conflict between them. According to the Research Institute for organic agriculture (Fi BL) (BDA certification, n. a.), Demeter regulations were the most stringent, with Demeter standards allowing the fewest food additives in processed food as compared to other labels.

To develop an appropriate method and to study designs for holistic examination is a major challenge of future research in biodynamic food and farming. Because for the analysis of holistic approach, specific method or study application are rarely implemented.

4. Conclusion

The studies on biodynamic farming are gradually increasing. These studies have provided many evidences for the effects of biodynamic management and food quality, effects on soil, compost application etc. Biodynamic preparations have invented various effects on the quality and chemical composition of food. Biodynamic management and the application of biodynamic preparation leads to differentiate between biodynamic and non-biodynamic vine-yards. Researches have proven that biodynamic agriculture is for sure very sustainable agricultural practices. The researchers have highlighted that there is a need for more sustainable agriculture to exist so that it can move forward. On the other hand the world still lacks the basic procedure for delivering sustainable developments. Until this change cannot be solved, the world's need to rely on the conventional agriculture in order to meet the demand of food in present as well as for the future.

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