

Biodynamic Farming: A Promising Path towards Tomorrow's Sustainable Agriculture

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ABSTRACT

Bio-dynamics is a holistic, ecological and ethical approach to farming, gardening, food and nutrition. Biodynamic farming is a form of alternative agriculture very similar to organic farming, but it includes various esoteric concepts drawn from the ideas of Rudolf Steiner. Bio-dynamics has much in common with other organic approaches. It emphasizes the use of manures and compost, and excludes the use of artificial chemicals on soil and plants. As of 2016, biodynamic techniques were used on 161,074 hectares in 60 countries. The biodynamic movement has reached India in the early 90's when Peter Proctor, a farmer from New Zealand working with biodynamic agriculture since 1965 was asked to come to India by T.G.K. Menon of Indore in 1993 to teach Indian farmers about biodynamic farming. Unlike most modern agricultural techniques, this practice is entirely environmentally and socially sustainable. Some researchers believe that a "large-scale shift towards biodynamic farming would not only increase the world's food supply, but might be the only way to eradicate hunger". Biodynamic agriculture is indeed a very sustainable agricultural practice in terms of environmental and social sustainability, where this practice lacks in economic sustainability. It is one of the most environmental friendly farming practices in the world and is well on its way to being one of the sustainable options for the future. So, more and more researches need to be conducted, in order to sustain the world's supply of food through organic means.

Keywords: Organic, Biodynamic, Sustainable, Food

INTRODUCTION

Biodynamic Farming- The first consciously organized organic movement. Biodynamic agriculture is a form of alternative agriculture very similar to organic farming, but it includes various esoteric concepts drawn from the ideas

of Rudolf Steiner (1861–1925). Initially developed since 1924, it was the first of the organic agriculture movements. It treats soil fertility, plant growth, and livestock care as ecologically interrelated tasks, emphasizing spiritual and mystical perspectives.

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PRINCIPLES OF BIODYNAMIC FARMING

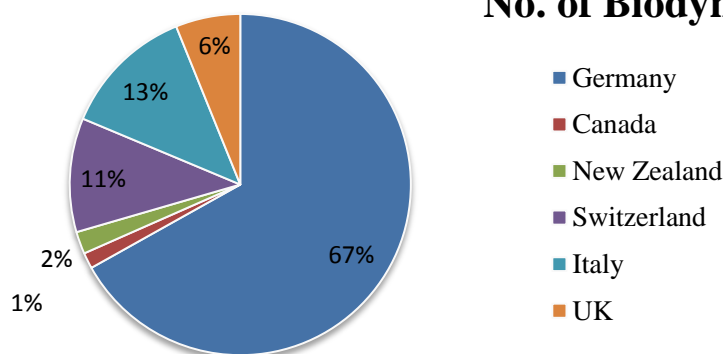
Rathore et al. (2014) and Pfeiffer (1940) states that the main principles of Biodynamic Agriculture are:

- To create a diverse and balanced farm ecosystem that can support itself from within the farm (Mason, 2003)
- To restore the soil through the incorporation of organic matter
- To treat soil as a living system
- To create a system that brings all factors which maintain life into balance
- To encourage the use and importance of green manure, crop rotation and cover crops

- Treat manure and compost in a biodynamic way, and have knowledge of enzymes and hormones.

Bio-dynamics has much in common with other organic approaches. It emphasizes the use of manures and composts and excludes the use of artificial chemicals on soil and plants. Biodynamic agriculture uses various herbal and mineral additives for compost additives and field sprays; these are sometimes prepared by controversial methods, such as burying ground quartz stuffed into the horn of a cow, which are said to harvest "cosmic forces in the soil", that are more akin to sympathetic magic than agronomy.

WORLD SCENARIO OF BIODYNAMIC FARMING



No. of Biodynamic farms

As of 2016 biodynamic techniques were used on 161,074 hectares in 60 countries. Germany accounts for more than 50% of the global total; the remainder average 1750 ha per country. Biodynamic methods of cultivating grapevines have been taken up by several notable vineyards. There are certification agencies for biodynamic products, most of which are members of the international bio-dynamics standards group Demeter International.

Today bio-dynamics is practiced worldwide and in a variety of circumstances, ranging from temperate arable farming, viticulture in France, cotton production in Egypt, to silkworm breeding in China. Demeter International is the primary certification agency for farms and gardens using the methods.

BIODYNAMIC MOVEMENT IN INDIA

Biodynamic Association of India (BDIAI), situated in Bangalore has taken the charge of promoting and coordinating the biodynamic movement in India. The movement has reached India in the early 90's when Peter Proctor, a farmer from New Zealand working with biodynamic agriculture since 1965 was asked to come to India by T.G.K. Menon of Indore in 1993 to teach Indian farmers about biodynamic farming. Places among the first initiatives were Kuriniji farms near Kodaikenal, Maikaal cotton project in Madhya Pradesh and the tea projects in Darjeeling and south India. Presently, places where BD farming has been followed extensively are Mysore (ISKON farm), Gujarat (Bhaikaka Krishi Kendra), Tamilnadu (Nandanvan est., Balmadies est.) etc.

BIODYNAMIC CERTIFICATION

“Healing the planet through agriculture”

Biodynamic certification is the process by which a farm is officially certified to produce biodynamic products by following BD methodologies. The certification process involves contacting a certifying agency, contracting with them for an inspection of the farm by their inspector and based upon their inspection a certified certificate is passed which is subject to renewal after a certain period of time. This certification is really important in case of global export market.

The term Biodynamic is a trademark held by the Demeter association of biodynamic farmers for the purpose of maintaining production standards used both in farming and processing foodstuffs. The trademark is intended to protect both the consumer and the producers of biodynamic produce. Demeter International an organization of member countries; each country has its own Demeter organization which is required to meet international production standards (but can also exceed them). The original Demeter organization was founded in 1928; the U.S. Demeter Association was formed in the 1980s and certified its first farm in 1982. In France, Biodivin certifies biodynamic wine. In Egypt, SEKEM has created the Egyptian Biodynamic Association (EBDA), an association that provides training for farmers to become certified. As of 2006, more than 200 wineries worldwide were certified as biodynamic; numerous other wineries employ biodynamic methods to a greater or lesser extent.

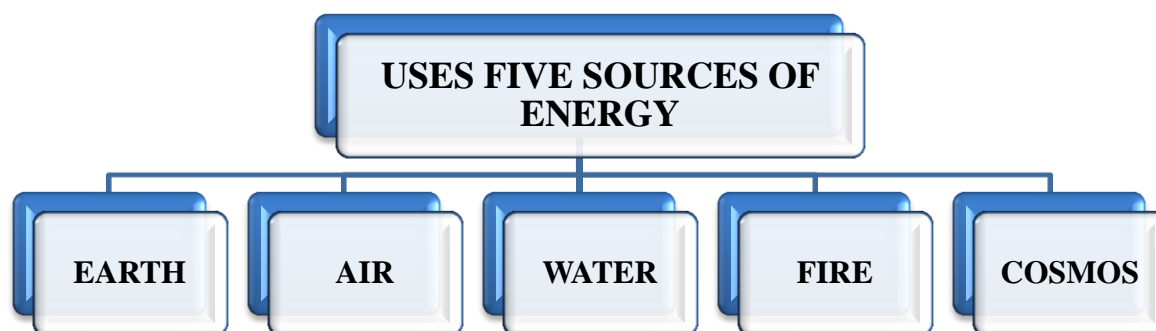
India is working with international biodynamic farming agencies to facilitate an internationally recognised set of standards to be used during the inspection of farms desiring biodynamic certification.

Biodynamic agriculture Vs Organic farming

The main differences between biodynamic and organic farming standards are:

- ***The farm is viewed as a close loop system***
Biodynamic farms should remain as enclosed from their surrounding ecosystems as far as possible. A fundamental principle which a biodynamic farm works towards is thus to be a 'closed loop' system that does not need to purchase feed or fertility from external suppliers, or one that is stretched beyond its natural capacity. In other words, where an organic farm may purchase organic seeds or organic feed for livestock, a biodynamic farm must produce everything on the premises.
- ***Composting is supreme***
The use of compost and manures enriched with biodynamic herbal preparations is unique to biodynamic farming.
- ***Biodynamic farmers have a tool box of natural remedies to support their farms***
The use of biodynamic herbal and mineral preparations to improve the health and vitality of land and crops is also unique to biodynamic farming.
- ***Biodynamic farmers often use a planting calendar***
Biodynamic farms are structured around lunar and astrological cycles that are said to affect the biological systems. Though not obligatory, a biodynamic astronomical calendar is can be consulted to help access optimum times for sowing, planting etc.
- ***Integrate all the living organisms within the system, including plants, livestock and farmers***
Plants, livestock and farmers are integrated within the system as a single organism.
- ***Soil is seen as the central component***
Improvement of plant health through soil health so, here soil is the major component which is taken care of properly.
- ***Use of special BD preparations***

COMPONENTS OF BIODYNAMIC FARMING



BIODYNAMIC FARMING PRACTICES

| BIOLOGICAL PRACTICES | DYNAMIC PRACTICES |
|-----------------------------------|-------------------------------|
| Green manures | Special compost preparation |
| Cover cropping | Special foliar sprays |
| Composting | Planting by specific calendar |
| Companion crop planting | Peppering for pest control |
| Integration of crop and livestock | Homeopathy |
| Tillage and cultivation | Radionics |

THE BIODYNAMIC PREPARATIONS

A distinguishing feature of biodynamic farming is the use of nine biodynamic preparations described by Steiner for the purpose of enhancing soil quality and stimulating plant life. They consist of mineral, plant or animal manure extracts usually fermented and applied in small proportions to compost, manures, the soil, or directly onto plants, after dilution and stirring procedures called dynamizations. The original biodynamic (BD) preparations are numbered 500–508.

FIELD PREPARATION

Field preparations, for stimulating humus formation:

- **500:** (Cow horn-manure) a humus mixture prepared by filling the horn of a cow with cow manure and burying it in the ground (40–60 cm below the surface) in the autumn. It is left to decompose during the winter and recovered for use the following spring.
- **501:** (Cow horn- silica) 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 (mixture of 1 tablespoon of quartz powder to 250 liters of water) The mixture is sprayed under very low pressure over the crop during the wet season, in an attempt to prevent fungal diseases. It should be sprayed on an overcast day or early in the morning to prevent burning of the leaves.

The application rate of the biodynamic field spray preparations (i.e., 500 and 501) are 300 grams per hectare of horn manure and 5 grams per hectare of horn silica. These are made by stirring the ingredients into 20-50 litres of water per hectare for an hour, using a prescribed method.

COMPOST PREPARATIONS

Compost preparations, used for preparing compost, employ herbs which are frequently used in medicinal remedies. Many of the same herbs are used in organic practices to make foliar fertilizers, turned into the soil as green manure, or in composting. The preparations include:

- **502:** Yarrow blossoms (*Achillea millefolium*) are stuffed into urinary bladders from Red Deer (*Cervus elaphus*), placed in the sun during summer, buried in earth during winter and retrieved in the spring.
- **503:** Chamomile blossoms (*Matricaria recutita*) are stuffed into small intestines from cattle buried in humus-rich earth in the autumn and retrieved in the spring.
- **504:** Stinging nettle (*Urtica dioica*) plants in full bloom are stuffed together underground surrounded on all sides by peat for a year.
- **505:** Oak bark (*Quercus robur*) is chopped in small pieces, placed inside the skull of a domesticated animal, surrounded by peat and buried in earth in a place where lots of rain water runs past.
- **506:** Dandelion flowers (*Taraxacum officinale*) are stuffed into the mesentery of a cow and buried in earth during winter and retrieved in the spring.
- **507:** Valerian flowers (*Valeriana officinalis*) are extracted into water.
- **508:** Horsetail (*Equisetum*).

Biodynamic preparations are intended to help moderate and regulate biological processes as

Well as enhance and strengthen the life (etheric) forces on the farm. The preparations are used in homeopathic quantities, meaning they produce an effect in extremely diluted amounts. As an example, just 1/16th ounce a level teaspoon of each compost preparation is added to seven- to ten-ton piles of compost. In India, the pancha gavya and amritha karaisal which are part of organic farming is also practiced in bio-dynamic farming.

THE PLANTING CALENDAR RHYTHMS

Many Biodynamic farmers refer to the astronomical calendar when planning activities such as pruning, cultivating, harvesting, and spraying the preparations. The Planting Calendar is about RHYTHMS - Cosmic solar & lunar/moon rhythms and Earth rhythms. It is an aid to our conscious and purposeful participation in these rhythms.

These are rhythms that sustain all life on Earth. Biodynamic farmers strive to bring life back into the soil, so that the food produced from this living soil has increased life force/vitality/ nutrition, enhancing the quality of human life.

The 6 Moon Rhythms are:

| | |
|-------------------------------|-----------|
| Full-new moon | 29.5 days |
| Full-new moon | 27.3days |
| Ascending-Descending moon | 27.3 days |
| Moon nodes | 27.2 days |
| Perigee-Apogee | 27.5 days |
| Moon in Zodiac Constellations | 27.3 days |

- The element most affected by the moon energies is water (for example, the sap in plants).
- In the 48 hours leading up to Full Moon there appears a distinct increase in the moisture content of the earth. The growth forces of plants seem to be enhanced.
- During the Full Moon period there is quick germination of seeds, fast plant growth, and a rapid re-growth of any cut, mown or pruned vegetation.
- Towards New Moon there is more activity underground in the soil and the flow of sap in plants is less strong.

| ASCENDING MOON | DESCENDING MOON |
|--|---|
| 1. Cosmic forces work above the rhizosphere | 1. Cosmic forces work below the rhizosphere |
| 2. Suitable for <ul style="list-style-type: none"> • Foliar application • Propagation activities • Sowing • Harvesting | 2. Suitable for <ul style="list-style-type: none"> • Compost • Transplanting • Land preparation and manure application • Harvesting of root crops |

PERFORMANCE OF BIODYNAMIC FARMING IN CONTEXT OF CLIMATE CHANGE AND SUSTAINABILITY

- Effect on soil health and fertility
- Sequestration of carbon
- Yield potential
- Nutritional quality of food
- Management of pest and diseases

IMPACT OF BIODYNAMIC PRODUCTION PRACTICES ON SOIL HEALTH

In Table No. 1. A quantitative and qualitative comparison between

commercial carrot and biodynamic carrot was undertaken by K. Perumal & T.M. Vatsala in 2002 with respect to physicochemical, microbial and chromatographic properties. The parameters are analysed before manuring, after manuring and after harvesting the crops. They observed that the physicochemical properties score higher after manuring while the microbial population count is more during post harvest condition.

Table No. 1. Physicochemical properties of carrot grown soil

| SOIL | pH | EC | N (Kg/ha) | P (Kg/ha) | K (Kg/ha) | OC (%) |
|----------------|-----|------|-----------|-----------|-----------|--------|
| Initial | 8.0 | 0.34 | 73 | 6.3 | 89 | 0.28 |
| Manure applied | 7.2 | 0.29 | 82 | 6.7 | 92 | 0.45 |
| Post harvest | 7.0 | 0.27 | 72 | 6.2 | 87 | 0.31 |

Table No. 2. Quantitative distribution of micro flora in carrot grown soils

| SOIL | TVC | RHIZOBIUM | AZOSPIRILLUM | AZATOBACTOR | FUNGI |
|----------------|-----|-----------|--------------|-------------|-------|
| Initial | 10 | - | - | - | 12 |
| Manure applied | 207 | 93 | 150 | 62 | 125 |
| Post harvested | 280 | 180 | 128 | 184 | 182 |

(TVC=Total Viable Count= $\times 10^6$ per gm of dry soil based on plate count method)

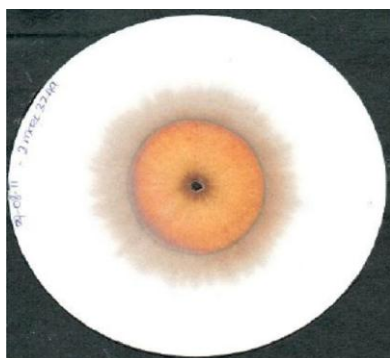


Fig. 1: Chromatogram of commercial carrot soil



Fig 2. Chromatogram of BD carrot grown soil

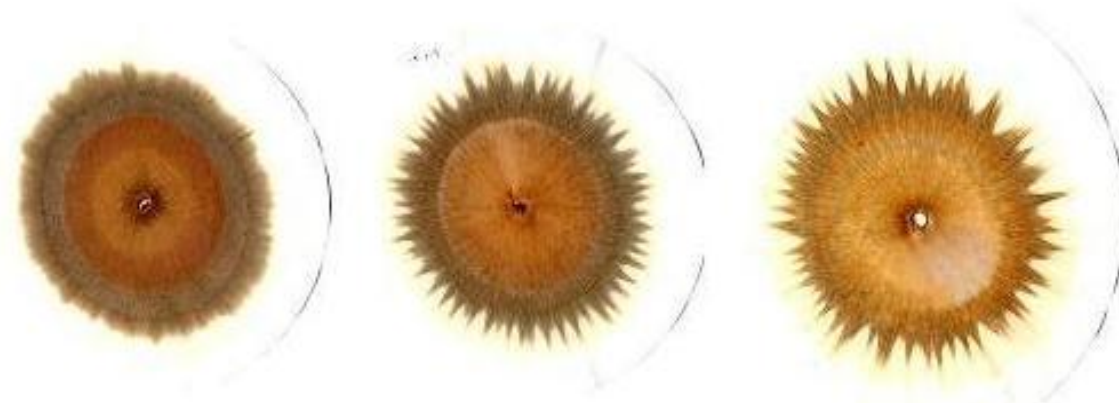


Fig. 3: Circular paper chromatographic images of (A) soil initial, (B) manure applied soil & (C) post harvested soil

In Table No. 2. Perumal and Vatsala 2002, Perumal et al. 2016 Chromatographic analysis is done in order to separate the different fractions in 0.1% alkali-water solutions (sodium hydroxide), which were subjected to Whatman No.1 filter paper analysis. In the chromatograms of carrots there were three zones inner, middle and the outer which reflect the presence of mineral, starch and proteins respectively. The chromatograms of biodynamically grown carrot showed a prominent inner zone (3.5 cm diameter) than that of the inner zone of conventional carrot (2 cm), which clearly indicated qualitative and quantitative differences in the availability of minerals. The spikes protruding from the middle zone towards the outer zone are caused by proteins. The chromatographic images of

soils indicated the improved condition of soil health. The chromatogram of soil (initial) indicated absence of the outer zone which reflect the lack of colloidal substances. The middle zone was faint, brown in colour and lack of forms that were mainly due to the availability of less organic material. The inner zone was comparatively larger and contains hardly any mineral sign.

In Table No. 3. Study was conducted on some chemical and biological properties of soil under biodynamic farming after two years of farming in CISH, Lucknow (R. K. Pathak and R. A. Ram, 2016). The study revealed that after two years of farming there is remarkable increase in available P, K, organic carbon content and also microbial colony of yeast, mould and bacteria is very high.

Table No. 3. Chemical and biological properties of soil under biodynamic farming

| | Initial | After one year | After two years |
|--------------------|-------------------|-------------------|-------------------|
| Organic carbon (%) | 0.5 | 0.8 | 1.0 |
| P (ppm) | 8.6 | 8.6 | 22.6 |
| K (ppm) | 140.0 | 142.5 | 202.5 |
| Yeast and mould | 1.3×10^4 | 5.8×10^4 | 8.5×10^4 |
| Bacteria | 3.7×10^6 | 4.8×10^6 | 8×10^6 |

In Table No. 4. Turinek et al. in 2009 studied the Soil Carbon (%) after 32 years in 'K-trial' in Sweden (1958-90) which is a long-term experiment and they found out that amount of total carbon is highest in case of biodynamic farming that is 160 t

C/ha and also depth wise amount of carbon is increasing as we go from surface to deeper layer as that of other farming systems like organic, NPK medium and NPK high.

Table No. 4. Level of Soil Carbon obtained from different soil depth

| Soil depth (cm) | Organic | Biodynamic | NPK fertilizer 'medium' | NPK fertilizer 'high' |
|-----------------|------------|------------|----------------------------|--------------------------|
| 0-10 | 3.1 | 2.9 | 2.6 | 2.5 |
| 25-35 | 2.1 | 2.4 | 2.0 | 2.3 |
| 50-60 | 0.9 | 1.3 | 0.9 | 0.6 |
| Total | 146 t C/ha | 160 t C/ha | 135 t C/ha | 135 t C/ha |

In Table No. 5. M. Turinek et al. (2009) studied Soil carbon sequestration benefits of biodynamic farming over organic farming. They compared two long term experiment that is 33 years of 'K-trial' of Sweden and 28 years of 'DOK-trial' of Switzerland under organic and biodynamic farming in different depth of soil. They found that there is higher amount of carbon sequestered in case of biodynamic

farming. Increasing the amount of carbon stored in vegetation and soil (also called carbon sequestration) is a preventative measure toward slowing carbon dioxide (CO₂) build-up in the atmosphere. Soil organic carbon was maintained at the same level and even showed a small gain in the BD system at the DOK trial and K trial, whereas the organic farming systems had a net loss of soil organic carbon.

Table No. 5. Soil carbon sequestration benefits of biodynamic farming over organic farming

| Location | Study | Soil depth | Organic farming (kg C ha ⁻¹ yr ⁻¹) | Biodynamic farming (kg C ha ⁻¹ yr ⁻¹) |
|-------------|-------------------------|------------|---|--|
| Sweden | 33 yr-'K-trial' | 60 cm | 300 | 800 |
| Switzerland | 28 yr-FIBL DOK trial | 20 cm | -123 | 42 |

In Table No. 6. L. M. Condrón et al. in 2010 studied the chemical properties of soil after two crop rotations under control, biodynamic, organic, conventional, mineral system in New Zealand. They

found out that the properties of soil like pH, total organic carbon, total nitrogen, extractable Ca and Mg highest under biodynamic farming than that of other four farming systems.

Table No. 6. Chemical properties of soil after two crop rotations

| SOIL PROPERTIES | CONTR | B-DYN | ORG | CON | MIN |
|--|-------|-------|-------|--------|--------|
| pH | 6.2a | 6.9c | 6.5b | 6.2a | 6.1a |
| Total organic carbon (g kg ⁻¹) | 14.8a | 17.7c | 16.4b | 16.1b | 14.5a |
| Total N (g kg ⁻¹) | 1.34a | 1.69c | 1.50b | 1.47ab | 1.41ab |
| Extractable P (mg kg ⁻¹) | 11a | 33c | 25b | 38d | 24b |
| Extractable K (mg kg ⁻¹) | 48a | 61b | 58b | 101d | 73c |
| Extractable Ca (g kg ⁻¹) | 1.81a | 2.47b | 1.96a | 1.84a | 1.78a |
| Extractable Mg (mg kg ⁻¹) | 68a | 101bc | 116c | 95b | 89b |

In Table No. 7. L. M. Condrón et al. in 2010 studied the Soil microbial properties of five production systems in a field experiment after two crop rotations. They found out that all that soil microbial properties like microbial biomass, microbial respiration and activity of the soil enzymes are highest in case of biodynamic farming than that of other farming systems. Microbial population in BD preparations was found to be substantial,

mainly in BD preparations 502 and 506. Several bacterial and fungal strains showed a potential for suppressing fungal plant pathogens. This could also be the reason for the significant and clear-cut difference in dehydrogenase, protease and phosphatase activities with respect to the farming systems and highest values were measured for the BD system.

Table No. 7. Soil microbial properties of five production systems

| SOIL PROPERTY | CONTR | BDYN | ORG | CON | MIN |
|--|-------|-------|-------|-------|-------|
| Microbial biomass (mg C_{mic} kg^{-1}) | 316a | 603d | 528c | 443b | 359a |
| $C_{mic} C_{org}^{-1}$ ratio (g kg^{-1}) | 24a | 34c | 32c | 27b | 25a |
| Respiration (μg CO_2 c $15 d^{-1} kg^{-1}$) | 258a | 324a | 302a | 295a | 273a |
| Dehydrogenase (mg TPF $6 h^{-1} kg^{-1}$) | 42a | 106d | 85c | 59b | 46a |
| Catalase (g H_2O_2 $h^{-1} kg^{-1}$) | 3.6a | 6.05c | 5.4bc | 4.4ab | 4.0a |
| Protease (mg tyrosine $2 h^{-1} kg^{-1}$) | 233a | 810d | 613c | 476b | 378b |
| Alkaline phosphatase (mg phenol $16 h^{-1} kg^{-1}$) | 112a | 1607d | 973c | 531b | 416ab |

In Table No. 8. Nath et al. in 2016 studied the chemical and biological Properties of soil after two yrs of rice cultivation. The following treatments like $T_1 = FYM$ (5 t/ha) + Rock Phosphate (100 kg/ha), $T_2 = FYM$ (5 t/ha) + Rock Phosphate (100 kg/ha) + Microbial consortium (including Zn solubilizer), $T_4 =$ Application of Panchagavya with water @ 50 lit/ha at transplanting, active tillering and PI

stage, $T_6 =$ Application of Amrithakaraisal with water @ 1250 lit/ha at transplanting, active tillering and PI stage $T_8 = T_1 + T_4$, $T_{10} = T_1 + T_6$. Here, T_1 and T_2 represents organic system of farming while T_8 and T_{10} represents biodynamic system of farming. Soil properties like available P, activity of DHA, FDA, PMA and microbial carbon is highest under T_8 and T_{10} than T_1 and T_2 .

Table No. 8. Chemical and biological Properties of soil after two years of rice cultivation

| | Av. N | Av. P | Av. K | DHA | PMA | FDA | MBC | Bac | Fungi |
|---------------------|--------------|-------|-------|--------------------------------|-------------------------|-----------------------|----------------------|-----|-------|
| | Kg ha^{-1} | | | μg TPF $g^{-1} 24 h^{-1}$ | μg $g^{-1} h^{-1}$ | μg g^{-1} soil | $\times 10^6 g^{-1}$ | | |
| Organic (T_1) | 200.7 | 12.8 | 166.7 | 133.6 | 244.3 | 8.6 | 128.5 | 5.5 | 5.3 |
| Organic (T_2) | 213.3 | 17.0 | 132.3 | 130.8 | 234.0 | 9.7 | 133.3 | 5.6 | 4.2 |
| Org+PG (T_8) | 169.3 | 15.9 | 134.1 | 136.2 | 257.6 | 8.9 | 229.3 | 5.3 | 4.4 |
| Org+AK (T_{10}) | 181.9 | 18.6 | 142.1 | 161.2 | 265.5 | 9.6 | 148.2 | 5.5 | 4.4 |

EFFECT ON YIELD POTENTIAL

In Table No. 9. R. K. Pathak & R. A. Ram in 2016 studied yield of various vegetables and fruits under conventional and biodynamic methods in CISH, Lucknow. They found out

that there is markedly higher yield in case of cauliflower, cabbage, gooseberry and mango under biodynamic system than that of conventional system.

Table No. 9. Yield of various vegetables and fruits under conventional and biodynamic methods

| | CAULIFLOWER (t/ha) | CABBAGE (t/ha) | GOOSEBERRY (kg/tree) | MANGO (kg/tree) |
|--------------|------------------------|-------------------|-------------------------|--------------------|
| Biodynamic | 42.5 | 56.1 | 46.6 | 70.0 |
| Conventional | 23.0 | 22.8 | 22.2 | 50.0 |

In Table No. 10. Sharma and co- workers (2012) studied the effect of biodynamic manure (BD 500 and BD 501) in combination with vermicompost and farm yard manure on growth and yield of cumin (*Cuminum cyminum* L.). The result showed that the

application of BD 500 and BD 501 along with either FYM @ 6t/ha or vermicompost @ 2t/ha recorded a significant increase of 20.56% and 12.85% in seed yield of cumin over the application of FYM @ 6t/ha and vermicompost @ 2t/ha alone, respectively.

Table No. 10. Effect of biodynamic manure in combination with vermicompost and farm yard manure on growth and yield of cumin

| Treatments | Seed yield (Kg/ha) | Straw yield (Kg/ha) | Biological yield(Kg/ha) | Harvest index (%) |
|--------------------------------------|-----------------------|------------------------|----------------------------|----------------------|
| T1 (vermicompost@2 t/ha) | 284.49 | 671.72 | 956.20 | 31.54 |
| T2 (FYM@6 t/ha) | 317.50 | 709.95 | 1027.45 | 32.78 |
| T3 (BD500+vermi@ 2t/ha) | 293.32 | 655.55 | 948.87 | 33.18 |
| T4 (BD500+FYM@6 t/ha) | 398.89 | 741.32 | 1140.21 | 33.91 |
| T5 (BD500+BD501+vermicompost@2 t/ha) | 388.07 | 719.50 | 1107.57 | 36.22 |
| T6 (BD500+BD501+ FYM@6 t/ha) | 447.51 | 768.70 | 1216.21 | 37.28 |
| T7 Absolute control | 198.12 | 457.52 | 655.63 | 30.72 |
| T8 Absolute control (water spray) | 6.97 | 444.58 | 662.56 | 33.41 |
| S.Em± | 6.97 | 13.39 | 25.47 | 0.83 |
| CD (0.05) | 21.14 | 40.60 | 77.24 | 2.50 |

In Table No. 11. D.J. Nath et al. in 2016 studied the effect of panchgavya and amritha karaisal on rice varieties viz. Bokul and Badsha Bhog under organic condition. The treatments taken into consideration are T₁ = FYM (5 t/ha) + Rock Phosphate (100 kg/ha), T₂ = FYM (5 t/ha) + Rock Phosphate (100 kg/ha) + Microbial consortium (including Zn solubilizer), T₄ = Application of Panchagavya

with water @ 50 lit/ha at transplanting, active tillering and PI stage, T₆ = Application of Amrithakaraisal with water @ 1250 lit/ha at transplanting, active tillering and PI stag, T₈ = T₁ + T₄, T₁₀ = T₁ + T₆, T₁₂= Control. T₁₀ treatment shows highest yield under Bokul variety while T₂ treatment shows highest yield under Badsha Bhog variety and as mean T₁₀ being the highest.

Table No. 11. Effect of panchgavya and amritha karaisal on rice varieties under organic condition

| | Bokul (V ₁) | Badsha Bhog (V ₂) | Mean |
|----------------------------|-------------------------|-------------------------------|------|
| Organic (T ₁) | 28.1 | 29.5 | 28.8 |
| Organic (T ₂) | 28.3 | 32.5 | 30.4 |
| Org+PG (T ₈) | 30.9 | 31.9 | 31.4 |
| Org+AK (T ₁₀) | 31.6 | 31.9 | 31.8 |
| Control (T ₁₂) | 20.8 | 26.6 | 23.7 |

PRODUCTION OF QUALITY FOOD

In Table No. 12. Rene E Valdez and Pamela G Fernandez in 2008 studied various quality factor of rice in Philippines. They had taken

three varieties i.e. Dinorado, PSBRc82, PSBRc72 H for their experiment and found out that most of the parameters are equal or more than that of synthetic and organic.

Table No. 12. Quality factor of rice

| Parameters | Control | Synthetic | Organic | Biodynamic |
|---|---------|-----------|---------|------------|
| Whiteness of raw grain | 8.23a | 8.27a | 9.13a | 8.61a |
| Gloss of raw grain | 1.00a | 1.18a | 1.33a | 1.09a |
| General acceptability of raw grain | 10.98a | 10.46a | 10.75a | 10.49a |
| Cohesiveness of freshly cooked grain | 5.32a | 4.89a | 5.60a | 5.26a |
| Tenderness of freshly cooked grain | 5.97a | 5.14a | 5.60a | 5.21a |
| General acceptability of freshly cooked grain | 8.47a | 7.56a | 8.11a | 7.75a |

In Table No. 13. To increase our understanding of the function of the alternative systems (organic - ORG and biodynamic - BD) when compared to the commonly practiced low-input (LCON) and high-input

conventional (HCON) approaches, a six-year field trial was conducted in the McLaren Vale region of South Australia by Penfold and Collins (2015).

Table No. 13. Comparison of different systems

| | ORG | BD | LCON | HCON | LSD (5%) |
|--------------------------|------|------|------|------|----------|
| Alcohol (%) | 14.0 | 13.9 | 14.3 | 14.4 | 0.13 |
| pH | 3.65 | 3.69 | 3.70 | 3.71 | 0.01 |
| Total acidity | 9.3 | 9.2 | 9.1 | 9.1 | 0.15 |
| Total anthocyanin (mg/L) | 297 | 301 | 303 | 337 | 19.6 |
| Total phenolics (mg/L) | 44 | 44 | 43 | 44 | NS |

Berry and wine compositional analysis was performed on berries, juice and wines from all treatment replicates. The main quality parameters measured in the literature included soluble solids, organic acids and pH, colour, phenolics and tannins. Significant differences in descriptors used by viticulturists and winemakers to describe wines made from fruit produced under the different management systems. Consistently ORG and BD treatment wines were described more often as being rich, complex, vibrant, balanced and textural compared to LCON and HCON treatment wines. LCON and HCON wines were also described more frequently as green and unripe compared to ORG and BD. In 2013 and 2014 ORG and BD were more often described as having black fruit and red fruit character.

LCON wines in 2012 were also described more as earthy.

Biodynamic way of disease and pest management

Pest management

- Cow horn silica controls fungal attack
- Biodynamic neem based liquid pesticides control soft pests (aphids, jassids, flies etc)
- Nettle spray controls hard insects.
- Spray of biodynamic pesticides prepared from cow urine, neem, karanj (*Pongamia glabra*), *Caliotropis*, castor, *Thevtia nerrifolia*, *Vitex spp.* Leaves.
- Nettle leaves extract sprays to control hard pests.

Disease management

- Two sprays of Cow Horn silica (BD-501) at flowering and fruit development stage.
- Biodynamic tree oaste/cowdung paste for the control of gummosis and dieback.
- Spraying of horsetail (*Equisetum arvensis*) / casuarina leaves extract for the control of fungal diseases in ascending moon

LIMITATIONS OF BIODYNAMIC FARMING

Biodynamic farming requires more labour than conventional farming practices, which makes the produce more expensive. It's also not very conducive to mechanization, so it's difficult to practice on a large scale and its distribution is also limited. It can also be seen as a pseudoscience by non-believers, a fact that contributes to a general lack of mainstream acceptance.

BIODYNAMIC FARMING: A SUSTAINABLE OPTION FOR FUTURE ?

The world Commission for environment and development (the Brundtlandt Commission) coined the definition of sustainable development in the year 1987 – it is defined as development which satisfies the needs of current generations without compromising the needs of future generations (WCED 1987). Currently, there is an ever-growing range of sustainability claims and indicators. Collectively however, all fail to establish operational and practical ways to understand what sustainability actually means, and to deliver it effectively (Guttenstein et al., 2010). As previously stated, it is estimated that the global food demand will double over the next 50 years (Tilman et al., 2002). This means more land will need to be utilised for farming. However, it is reported that half of our planets terrestrial farmland is already being used to its full potential (Carpenter et al., 1998; Tilman et al., 2002). The majority of the earth's farmland is exploited due to the industrialised nature of our modern farming practices. Once land has been used beyond its carrying capacity, the

soil very rarely regenerates back to a fertile state, leaving it barren and useless (Brown & Kane, 1995). This is where biodynamic agriculture can be of a massive advantage to the agriculture sector. Unlike most modern agricultural techniques, this practice is entirely environmentally and socially sustainable. A study by Tavernier & Tolomeo (2008) states that sustainable agriculture is an approach that needs to clearly maximise economic and social benefits while at the same time maintaining environmental quality. Some researchers believe that a “large-scale shift towards biodynamic farming would not only increase the world's food supply, but might be the only way to eradicate hunger”

CONCLUSION

Biodynamic agriculture has been around since the 1920's, however it is still very much in its infancy. Every day it is being developed and is slowly becoming incorporated into the modern agricultural world. Despite the mystery and criticism that surrounds biodynamic agriculture, the practice itself is as sustainable and self sufficient as you can get in this current era. Biodynamic agriculture is indeed a very sustainable agricultural practice in terms of environmental and social sustainability, where this practice lacks in economic sustainability. It is one of the most environmental friendly farming practices in the world and is well on its way to being one of the sustainable options for the future. Many research showed that BD farming improves soil health and fertility (Perumal & Vatsala 2002, Condron et al. 2010), sequester higher amount of carbon on long term basis (Turinek et al., 2009) which helps to combat climate change, provides better or equal yield potential than that of other farming systems (Sharma et al. 2012, Pathak & Ram 2016), produces quality food with better taste (Penfold & Collins 2016, Valdez and Fernandez, 2008), manage insect and pest in a eco-friendly manner. Furthermore, for biodynamic agriculture to exist as one of our future sustainable options more research would need to be conducted and more information needs to

be made open to the public. The world of biodynamic agriculture is still a much closed community; and because of this the public can still be very sceptical. Nevertheless, we cannot keep relying on conventional agriculture when it causes so much damage to our fragile planet. Even still, right now it is practical to continue in this way, as it is the main supplier of our food. Until we have the ability to rely on sustainable methods for farming, we need conventional agriculture to meet our global food demand.

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