Reference: Zanoli, R.; Krell, R. (eds.) (1999): Research Methodologies in Organic Farming. FAO Regional Office for Europe; REU Technical Series 58; 41-47

BIODYNAMIC APPROACHES IN RESEARCH AND DEVELOPMENT

J. RAUPP

INTRODUCTION

We often experience that people expect something absolutely different, something very unusual or even strange when the conversation turns to biodynamic agriculture. Some people suppose biodynamic agriculture is like a cow with four horns and two wings or biodynamic farming relies solely on spiritual forces without looking at fertilization and plant protection techniques.

You will probably be disappointed if you have a similar expectation now for my contribution. Biodynamic approaches in R&D do not mean that we do everything completely different from the rest of the world. We share many experiences, habits and views with the other types and groups of organic farming and share many research topics and methods with the general scientific community. As the biodynamic fraction is the oldest part of the organic movement, some habits and views might have been developed first by this group but are not used by them exclusively.

However, it is indeed true that biodynamic agriculture has some characteristic aspects of farming, nutrition, etc. that are intrinsic to and found only in this agricultural method. From these particular aspects, specific problems concerning research and development may arise. Therefore, specific tools or approaches have been developed and must be developed for these problems. This is an on-going process that has not yet come to an end. My intention now is to describe some of these particular aspects of biodynamic agriculture from my personal point of view and their consequences for R&D.

With regard to the expectations I mentioned at the beginning, please consider that some of the consequences that I point out may also concern organic farming or agricultural research in general, at least in a similar or transformed way.

SOME PARTICULAR ASPECTS OF BIODYNAMIC AGRICULTURE

Basic Background: Anthroposophy

The biodynamic method originates in the lectures of Rudolf Steiner (Steiner, 1924). He assumed a fundamental knowledge of anthroposophy, the spiritual science developed by himself. Without such knowledge, biodynamic agriculture can be applied but not fully understood with its essentials, e.g. the biodynamic preparations. Knowledge of anthroposophy cannot normally be achieved through ordinary education in schools, universities, etc. It is usually gained by private study and special courses.

The fact that a fundamental background exists means that deeper involvement in biodynamic farming should be accompanied by a study of anthroposophy. This is valuable to scientists as well as to farmers, advisers or even to consumers, as it offers another approach also to human nutrition. However, to pursue an additional study needs further time and effort. It may sometimes be difficult to communicate with people not having this background. In other words, you can tell everybody WHAT you do in biodynamic farming but only to a certain extent can you explain WHY you do it.

To date, a great number of studies and many hundreds of publications have been produced in the field of agriculture and ecology based on anthroposophy, referring to the work of Steiner and other authors. It is impossible to give a representative review of the literature here. Beismann and Rozumek (1997) attempted to give a comprehensive description and a historical outline of this topic including a bibliography of anthroposophical magazines.

Biodynamic Preparations

Steiner (1924) recommended eight preparations (Table 1); two of them are stirred in water in a specific way and sprayed on fields and crops, the other six preparations were added to farmyard manure, slurry, liquid manure, plant litter compost and any other type of organic materials in order to improve their fertilizing properties. Some other preparations or rather modifications of these eight have been developed here and there, but they are much less widespread in practice than the original preparations and are scarcely investigated.

Table 1. Biodynamic preparations (Steiner, 1924)

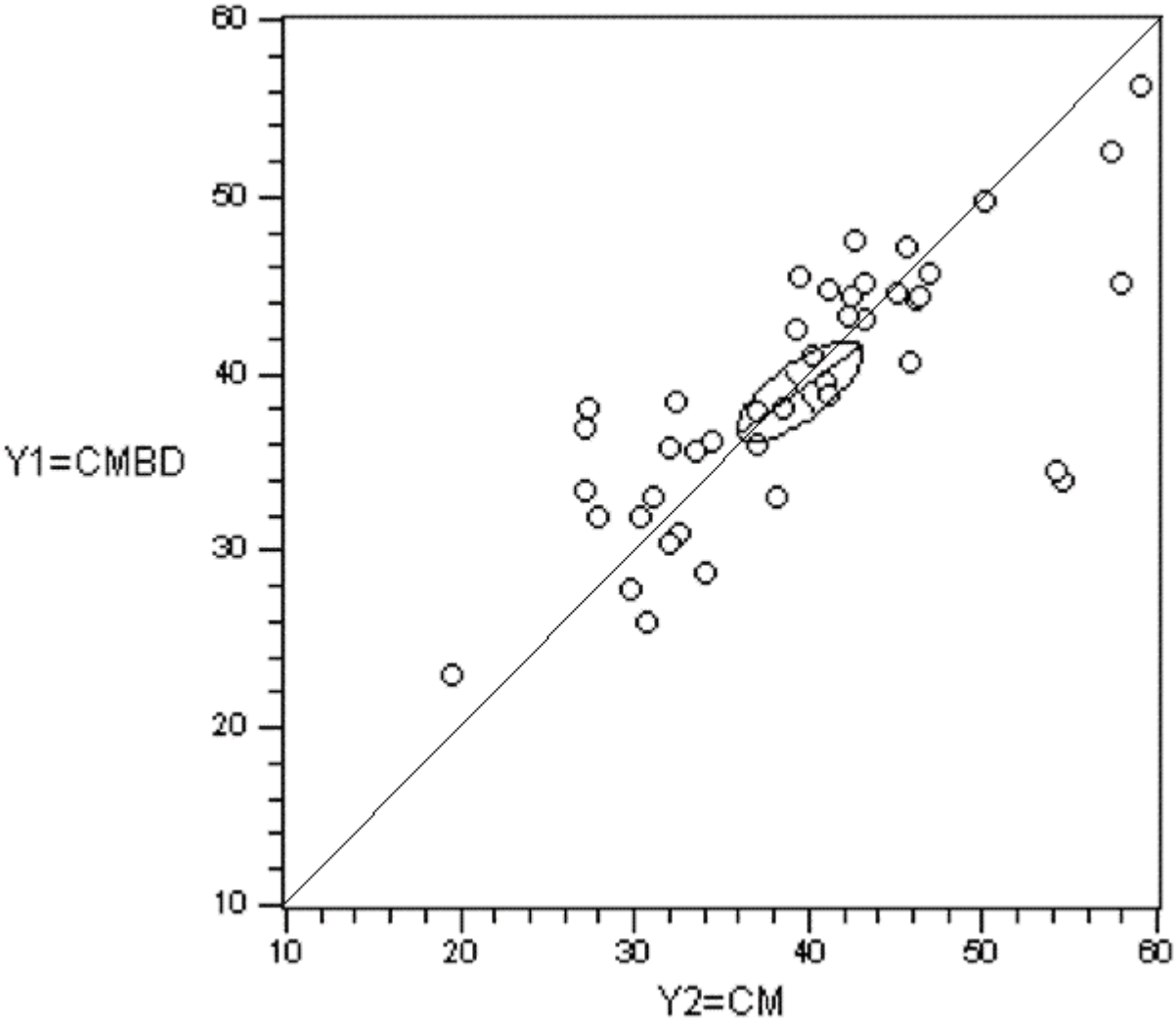
Spray preparations applied to soils and crops:	
500	Horn manure
501	Horn silica
Manure preparations:	
502	Yarrow (Flower heads from *Achillea millefolium*)
503	Camomile (Flower heads from *Matricaria chamomilla*)
504	Stinging nettle (stalk from *Urtica dioica*)
505	Oak bark (*Quercus robur*)
506	Dandelion (flower heads of *Taraxacum officinale*)
507	Valerian (juice of flowers of *Valeriana officinalis*)

Each of the preparations is made in a specific way and applied in very small quantities, a feature shared with homeopathic remedies. Therefore, research on the preparation effects and way of action is very difficult. We are all more used to quantitatively linked effects, i.e. a larger effect is expected if an agent is applied more often or in a higher quantity within a certain range. However, the biodynamic preparations do not show a clearly discernible dose effect. Moreover, the extent and direction of an effect seems to vary depending on the prevailing circumstances (e.g. growth conditions), as can be concluded from the results of several studies (Abele, 1973; Dewes and Ahrens, 1990; Koop, 1993; Kotschi, 1980; Spiess, 1978 and 1979).

From these experimental results, the concept of system adjustment was derived and can explain some aspects of the preparation mode of action (König, 1993; Raupp and König, 1996). This concept fits, for example, the yield results of spring wheat in one of our fertilization trials. Figure 1 shows the yields of two treatments in 11 years (in four replicates). The yield with composted manure without biodynamic preparations (CM) is plotted against the horizontal axis and the yield achieved in the same year with composted manure including the application of all biodynamic preparations (CMBD), is plotted against the vertical axis. There is obviously a great variation from year to year within both parameters and on average, from 11 years yield no difference showed between the treatments with and without the preparations (39.0 and 39.5 dt/ha, respectively). Regarding the influence of years as a random effect, one has to conclude: no effect of the preparations on average. However, a significant bivariate correlation can be calculated between CM and CMBD, which shows a declining tendency of the CMBD results with increasing CM values. When, however, CM results were low, the CMBD treatment

yielded higher. This means, the preparations increased wheat yield under bad growth conditions (when the control treatment CM had low yields) and under high yielding conditions the preparations reduced yield a bit. The slope of the major axis of the correlation ellipse shown in Figure 1 is significantly smaller than 1 ($p<0.05$), providing evidence of the described effect.

Figure 1. Spring wheat yield with composted manure in 11 years; CMBD = with biodynamic preparations, CM = without; major axis: Y1 = 0.724 * Y2 + 10.43



I do not present this example because of the mathematical procedure; the bivariate correlation used here is quite a normal statistical tool. I present this example because of the concept of system adjustment as a way of action of the biodynamic preparations that can be described with this procedure. System adjustment is more focused on varying environmental conditions rather than expecting linear, quantitative effects. According to this concept, the effect of the preparations is not completely determined by their properties and mode of application but depends very much on the conditions of soils, plants and the environment, including their interactions.

A similar way of influencing organisms can be found in medicine. Schaumann (1987) points to the three basic ways for working with systems and organisms both in medicine and agriculture: stimulation, substitution and suppression. As the author points out, each system or organism has an inherent capability, to a certain extent, to regulate and adjust its processes and conditions. Depending on the way of treatment or therapy, this inherent capability can be stimulated or suppressed. By giving a certain therapy or medicinal preparations to an organism it is possible to stimulate the productive and harmonizing forces of nature in a single organism as well as in an agricultural system.

Schaumann (1987) suggests this view of stimulation for the action of biodynamic preparations. Following this view, the search for new experimental designs and statistical methods for research can be encouraged. Moreover, our knowledge and understanding of organisms and their processes will be enlarged.

Need for Education and Training

Of course, enlarged knowledge is also a matter of education. As already mentioned above, training and education in biodynamic agriculture and anthroposophy are only offered by private institutions (except for a short basic course at the Agricultural University of Wageningen, The Netherlands, currently under discussion). Table 2 shows some examples from European countries, (not complete). Only those institutions having long courses (lasting many months or some years) are shown. Organizations and institutions which offer short introductory courses of a few days or weeks are not considered here. There are approximately 20 in Europe.

Established and run by private initiative and support, these institutions usually have to be paid by the people who attend a course. This is a severe obstacle to many, mainly young people, who have to register. People who want to have such an education, will not only spend extra time and effort but also extra money. More private or public grants for the people would make the decision to attend a course easier in many cases. Most people use these courses as a supplement to their ordinary professional training. This demonstrates an obvious lack in public education (usually available free of charge).

Table 2. Some examples of private institutions offering long-term courses in biodynamic agriculture and anthroposophy in Europe

Emerson College, United Kingdom
Skillebyholm, Sweden
Landbauschule Dottenfelderhof, Germany
Hofgut Rengoldshausen, Germany
Warmonderhof, Netherlands
Formation en Agriculture Bio-Dynamique, France

Farm Level as an Important Consideration

One of the key issues Steiner introduced in his agricultural lectures is the concept of the farm as an individuality. The entire farm should be organized like an organism and developed as a unique individual under its natural, economic and social site conditions. Everything which is essential for life in a farm should be produced within the farm. Certainly this does not mean that each farmer should produce his own combine harvester. The point is, for example, all the fertilizers and feedstuffs which are needed should be brought out of the farm itself. In other words, the farm should have a balanced ratio between livestock and land use, a minimum area per livestock unit. In terms of today, Steiner perhaps would speak of the *farm agro-ecosystem*.

Like a farm, an ecosystem can be regarded as an organism on a higher level in which various components depend on, work for and with each other. However, the term *ecosystem* was still unknown during Steiner's lifetime; it was first used in 1935 by Tansley.

In some textbooks, also translated into English, the description of biodynamic agriculture starts with the concept of the farm organism or farm individuality (Koepf *et al*., 1976; Sattler and Wistinghausen, 1992) which shows the particular significance of this view. It is very important to consider that this concept is not a fixed and constant idea, but has to be adapted to various site conditions in different regions and continents. I think, this poses a research problem of very high priority, as organic farming has spread worldwide and meanwhile strong tendencies towards specialized farm types can be observed and need to be investigated thoroughly. Moreover, it is characteristic of organic farming that the farm is consistent with its local conditions and works with them. Examples for R&D projects which aim at the evaluation, development and improvement of organic farming at the farm level, has been described by Köpke (1993) and Kaffka and Koepf (1989).

CONSEQUENCE: IMPORTANCE OF COOPERATION

Research activities started soon after Steiner's lectures, at that time mainly carried out by biodynamic farmers on their farms (probably some decades earlier than the creation of the term *on-farm research*). Koepf (1993) gave a short description of research topics and institutions developed from the twenties to date, in different countries of Europe and the United States. A new, expanded edition has been published in German (Koepf, 1996). This shows that biodynamic agriculture has been connected with R&D activities from its beginning and that private institutions are an important factor in this regard. Most of these institutions, still existing today, are relatively small compared to a university or another public institute, because the available budget, usually provided more by private foundations than by public funds, is the most limiting factor.

Biodynamic farming as well as related research, has to deal with very complex problems. Many topics require a high degree of specialization, e.g. in plant or animal physiology or soil biology. However, it is just as important to have a total sound knowledge and understanding of farming. Thus, cooperation with other experts is necessary and from my experience, can be very stimulating and fruitful. By means of cooperation, different backgrounds and views can be realized. However, cooperation is not easy in each case, for various reasons. It demands, to a great extent, from each partner fairness and open-mindedness. This is especially true as regards biodynamic projects because of reasons already explained.

Table 3. Main research topics of the Institute for Biodynamic Research, Darmstadt, Germany

· Crop yield, product quality and soil fertility depending on fertilization
· Breeding and preservation of valuable cereal cultivars
· Development of agents for biological pest control; a consultation service for farmers
· Optimization of production and application of biodynamic preparations
· Weed control
· Development of methods for food quality assessment
· Documentation of research results and experiences

The Institute for Biodynamic Research in Darmstadt (Germany), for which I work, is the oldest private research institute for organic and biodynamic farming in Europe. Cooperation with other private and public research institutes plays a very important role in our work. This is not only the result of limited staff and financial resources, but also in order to combine different backgrounds and disciplines. Table 3 shows the most important topics on which currently one or more projects are under way. We use partly common research methods and tools, like field and pot trials, chemical and biochemical analyses and partly new methods or criteria are developed, e.g. for food quality assessment (protein analysis with wheat, durability of potatoes). A project on the picture creating methods is going to be launched in cooperation with a Swiss and a Danish organization. A recently finished project on fertilization based on long-term trials has been carried out in cooperation with six other institutes in Denmark, Finland, Germany, Sweden and Switzerland. Some of our activities in plant breeding are part of a German-Swiss group of biodynamic breeders (Kunz *et al*., 1997). An important element of biodynamic plant breeding is the regional development and preservation of cultivars which can (under certain preconditions) or should be done by each farmer (Spiess, 1996; Müller, 1996). Therefore, the biodynamic approach in this field is in contrast to the current tendency towards commercial breeding by large international companies, but is in line with the aims of sustainable regional development. Another research topic in our institute is, of course, the optimization of the biodynamic preparations and investigations on their effects. This includes, for example, experiments with different stirring methods for the spray preparations. The effects are evaluated by classical parameters (plant growth, chemical contents, etc.) and by picture creating methods.

More information is available in our publications.

ACKNOWLEDGEMENT

I am grateful to Dr Uli Johannes König for his comments on the manuscript.

REFERENCES

ABELE, U. (1973): Vergleichende Untersuchungen zum konventionellen und biologisch-dynamischen Pflanzenbau unter besonderer Berücksichtigung von Saatzeit und Entitäten. PhD-Thesis University of Gießen.

DEWES, T. and E. AHRENS (1990): Wechselwirkungen zwischen organischer Düngung und der Anwendung des biologisch-dynamischen Präparates P500 im aeroben Inkubationsversuch. Agribiol. Res. **43**, 65-73 pp.

KAFFKA, S. and H.H. KOEPF (1989): A case study on the nutrient regime in sustainable farming. Biol. Agric. & Hortic. **6**, 89-106 pp.

KÖNIG, U.J. (1993): Systemregulierung - Ein Wirkungsprinzip der biologisch-dynamischen Präparate. In: Zerger, U. (ed.): Forschung im ökologischen Landbau; SÖL-Sonderausgabe Nr. 42; 394-396 pp.

KOEPF, H.H. (1993): Research in biodynamic agriculture: methods and results. Bio-Dynamic Farming and Gardening Assoc. Inc., Kimberton PA, USA.

KOEPF, H. (1996): Biologisch-dynamische Forschung. Methoden und Ergebnisse. Verlag Freies Geistesleben, Stuttgart.

KOEPF, H.H., PETTERSSON, B.D. and W. SCHAUMANN (1976): Bio-dynamic agriculture. Anthroposophic Press, Spring Valley, New York.

KÖPKE, U. (1993): Forschungsinhalte und -konzepte des ökologischen Landbaus. Projekt "Ökologische Leitbetriebe in NRW". Ökologie & Landbau, Heft 87, 12-16 pp.

KOOP, W. (1993): Der Einfluß unterschiedlicher Düngerarten (mineralisch, organisch, biologisch-dynamisch) auf bodenmikrobiologische Indikatoren und Parameter der C- und N-Dynamik im Feldversuch und in Laboratoriumsversuchen. PhD-Thesis University of Gießen.

KOTSCHI, J. (1980): Untersuchung zur Wirkung der in der Biologisch-Dynamischen Wirtschaftsweise verwendeten Spritzpräparate "500" und "501" auf landwirtschaftliche Kulturpflanzen. PhD-Thesis University of Gießen.

KUNZ, P., MÜLLER, K.-J., SPIEß, H., HEYDEN B. and E. IRION (1997): Der “Weizen-Ringversuch”: biologisch-dynamische Weizenzüchter schließen sich zusammen. Lebendige Erde **48**, 110-114 pp.

MÜLLER, K.-J. (1996): Welchen Weg eine ökologische Getreidezucht nehmen könnte. Ökologie & Landbau, Heft 99, 11-14 pp.

RAUPP, J. and U.J. KÖNIG (1996): Biodynamic preparations cause opposite yield effects depending upon yield levels. Biol. Agric. & Hort. **13**, 175-188 pp.

SATTLER, F. and E.V. WISTINGHAUSEN (1992): Bio-dynamic farming practice. Publ. by the Bio-Dynamic Agricultural Assoc., Woodman Lane, UK.

SCHAUMANN, W. (1987): Vom Wirken mit Stoffen (III). 3. Die Stimulation der produktiven und ordnenden Kräfte der lebendigen Natur. Lebendige Erde no. 5, 251-256 pp.

SPIESS, H. (1978): Konventionelle und biologisch-dynamische Verfahren zur Steigerung der Bodenfruchtbarkeit. PhD-Thesis University of Gießen.

SPIESS, H. (1979): Über die Wirkung der biologisch-dynamischen Präparate Hornmist "500" und Hornkiesel "501" auf Ertrag und Qualität einiger Kulturpflanzen (I). Lebendige Erde no. 4, 126-131 pp.

SPIESS, H. (1996): Was bringt der Anbau von “Hofsorten”? Vergleichende Untersuchungen zum langjährigen Nachbau von Getreide bei ökologischer Bewirtschaftung. Ökologie & Landbau, Heft 99, 6-10 pp.

STEINER, R. (1924): Geisteswissenschaftliche Grundlagen zum Gedeihen der Landwirtschaft. 8 lectures 1924; 5th edition, Steiner Verlag, Dornach, 1975.