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Introduction

Moving worldviews are easily connected with a change from the dominating Western worldview towards the worldviews of for instance Bolivian, Ghanaian or Indian people. In these countries, as a result of specific religious aspects present in these cultures, people developed other ways of behaving towards each other and their surrounding world. However, there are also different worldviews present within Western society, although there is little acceptance of other scientific paradigms. The influence of Western science in our society is so strong, that alternative methodologies and ideas like homeopathy are strongly suppressed. An example of a Western alternative worldview on farming is biodynamics and its background in anthroposophy. The strength of anthroposophy is that its philosophy is connected with a theory (epistemology), new research approaches (methodology) and a vitalistic view on substances (ontology) (Gloy, 1998). In this paper, the consequences of the anthroposophical worldview in relation to agriculture are discussed.

All forms of sustainable agriculture are knowledge-intensive. Organic farming has expanded the horizons of agricultural practice. It is questionable, therefore, whether or to what extent the methods, techniques, social approaches and organisation that have been used in agricultural research and extension to intensify conventional agriculture are suitable for supporting organic farming (Röling & Jiggins, 1998). A paradigm shift is needed. It is clear that organic farming calls not only for new knowledge and techniques, but also for new attitudes, socio-economic behaviour and mentality in farm practice, in science and advice. With regard to systemic and participatory development, Bawden et al. (2000) describe the intensive reform of the agricultural curriculum at the University of Western Sydney. The stepwise evolution of methods of research and extension has also been described for agricultural changes in the developing countries (Chambers, 1992).

Since 1981 there has been a research- and teaching programme in ecological agriculture at the University of Kassel, Department 11. During the last five years there has been a unique situation, where there are 17 professors specialising exclusively in a number of aspects of organic farming. This has meant an enormous process of conversion within the existing, conventional agricultural education at the Kassel University. However, students have asked specifically for training and education in the field of biodynamic farming, which is one of the oldest types of organic agriculture (Vogt, 2000). Biodynamic farming, which seeks to implement anthroposophical

principles in farming practice, distinguishes itself from other blood groups by its emphasis on the life forces that play a key role in agriculture. Agriculture is not just a matter of physical, chemical or even biological (in the sense of genetic and evolutionary) processes. This emphasis on life forces adds several very essential additional considerations with respect to the objectives and especially the practices followed in organic farming. The key differences are:

- The emphasis on the farm- and site-specific nature of farming – the farm is seen as a living entity on its own (Steiner, 1924);
- The use of methods to identify and manage life forces (e.g., the use of certain compounds in compost making);
- The emphasis on the intrinsic nature of beings and their integrity (Verhoog et al., 2002), and the effort to understand these e.g. through Goethean research approaches (Bockemühl, 1980);
- The central role of human spirituality in relation to the development of the universe and its consequences for human nutrition.

In this paper, I start by introducing my personal experiences in the field of biodynamic training/education and research. Several biographical developments significantly affected my view on education and research. I call these changes paradigm shifts. My worldview has moved from a reductionist, negative and competitive view towards a more holistic, spiritual view. I highlight the steps of change I have undergone below to show that these changes were accompanied by inner conversions.

Biographical aspects

Born in Amsterdam (1956), at an early age I wanted to become a veterinarian. During teenage summer holidays I was introduced in farm life and met different farm animals on a small farm. Because of the small number of places available at Veterinary School I was not admitted first time round. I therefore decided to start a degree in biology, specialising in ecology. By the end of the first year, I had become overwhelmed by the scale of the environmental problems threatening the continuity and the sustainable development of our world. I felt it was my personal responsibility to solve these environmental problems, and the ecological knowledge offered at the university was my first adult awakening. Although in the second year, I was offered a place at Veterinary School, I decided to continue my study in ecology. My interest in new alternative food and nutrition philosophies increased, as I felt that conventional agriculture had not only strongly reduced the quality of our nature and landscape, but had also decreased the quality of our food. I became a vegetarian for a period of more than 10 years. After a short interest in macrobiotic food, I encountered 'alternative' agriculture. In those days, alternative agriculture in the Netherlands was dominated by the biodynamic movement, in terms of size and inspiration. I remember that in contrast to other biology students, I was convinced that organic agriculture was the right answer to a number of environmental, social and economic problems within society because of its holistic character. For me, organic agriculture included

comprehensive solutions (for the environment, animal welfare, the third world and farmers' incomes) rather than separate solutions. I started to develop a deep antipathy to symptomatic solutions, which did not radically change 'false' farming situations. Philosophically, I did not feel comfortable with the so-called 'critical biologists' in the Netherlands, who were connected within the Leiden Group of Environmental Biologists (Milieubiologie) and the Centre for Agriculture and Environment (CLM) in Utrecht. Those groups were much more politically oriented and in my opinion, the scientists involved were merely attacking the negative sides of conventional agriculture to reduce its negative outcomes. It was simply not my way of living.

So my first paradigmatic conversion was based on these new ecological insights gathered in the first 3-4 years of my biology study. It was not the world that had changed, but I had changed through an inner development. This new view on the world opened up my thinking about relationships (auto- and synecology), interdependence and sustainability, and last but not least, made me feel responsible for the world we live in and the earth we live on. Rather than knowledge of single facts, insight based on the understanding of ecosystem processes became important and relevant (Bormann & Likens, 1979).

In 1978/79 I followed a part-time course on biodynamic agriculture at Kraaybeekerhof. I combined this with volunteer work at one of the oldest biodynamic horticultural farms in the Netherlands: Sloterland, which was established in 1937. On this 1.5 ha farm a wide range of crops and fruits were grown, hedges housed bird life and compost was used to improve soil fertility. Two elements in this Kraaybeekerhof training changed my thinking about life and opened up new areas of the 'same world'. Again, it was not the world that had changed, but my relationship and my observations of the world through the following:

- A holistic way to teach biology, called Goethean phenomenology (or Goethean science, Bockemühl, 1980; Seamon & Zajonc, 1998);
- The anthroposophical view on the development of the earth, the evolution of man and the central role of man in nature.

Although I was in the middle of a scientific degree in biology at Utrecht University, my worldview had changed for a second time as a result of this Goethean phenomenological method. The Goethean scientific method examines the non-physical elements of the world. Goethean science has proved to be an essential method to elaborate reductionist observations and the method is intended to reconcile reductionist and holistic approaches. Goethean science has opened up a scientific road map to become connected with what is observed and to investigate the non-material elements present in the world. The German poet Wolfgang von Goethe was searching for the essentials in the world. Within himself, Goethe discovered the imaginary 'proto-plant', a non-physical idea of plants, which covered all potential plant shapes present in the world (Von Goethe, 1978).

In my personal development, I will never forget the inner flash I had, when after weeks of repeated observations of a group of trees and bushes, making drawings and looking for the expression of their growth gesture, I experienced the natural growth and development of the trees during spring time as an upward movement, which was connected with changes of colours over time. This step towards an empathic observation in terms of a *growing process* I experienced as my second paradigmatic change. Rather than a scientific interest for facts and figures, which only could be

measured and weighed, I became interested in natural processes of development, which were the essential elements of life (Schad, 1985). In later times, I realised that this change was a fundamental one from a philosophical point of view. With Goethean science, I crossed the border which separated positivism in science from constructivism within real world experiences. The object-subject relation changed due to Goethean science. Attitudes such as involvement, connectedness and expression were important elements of this new science and these attitudes opened up new areas of the world around me. Due to the scientific work of Jochen Bockemühl (1980, 1977), the Goethean methodology could be learned in a scientific way.

At the same time, anthroposophy presented me with the realistic existence of a spiritual world, which was not only present in a Sunday feeling of church religion. More like native American Indians, I felt that spirit was present in everything around me. Although church religion had been part of my childhood, I left the protestant church at the age of twenty. At the same time, anthroposophy revived my religious feelings in a more spiritual way. Spirits were present everywhere in the world surrounding me, accompanying plant growth for instance and not only far away in heaven. I became aware of a realistic connectedness of matter and spirit. For instance, spirit was also connected with plants and an elemental world accompanied each plant in its growth and development. Due to anthroposophy, I no longer lived in two separated worlds: a Sunday world of religion and mid-week world of materialism. Anthroposophy distinguished different non-materialistic qualities, which were described as different bodies (e.g. the etheric, astral and I-body). A range of spiritual entities accompanied the living world everywhere and at all times. Additionally, anthroposophy positioned man in a different relation to the rest of nature, and evolutionary development was completely opposite to the Darwinian worldview, closer to Intelligent Design. From this spiritual point of view, man was not the last step in evolution, but rather the first step in evolution (see also Bolk, 1930). Evolution was not a matter of coincidence and trial and error, but development was present with a goal. At the same time, the physical development of species, represented by fossils, is not denied (Mees, 1990; Verhulst, 1999 and Bosse, 2002). Due to anthroposophy, life in general as well as my personal life acquired sense, because of the presence of human faith and reincarnation, this offered me respectively goals in life and new possibilities later on. The understanding of anthroposophy and its integration in my way of living and my scientific life was my third paradigmatic change in the understanding of the surrounding world.

In 1985 I started working as a scientist at the Louis Bolk Institute in Driebergen in the Netherlands. The roots of this institute are in anthroposophy and the Goethean approaches are practised in the scientific work. Additionally, other anthroposophical methods were used to investigate the so-called etheric or living world. Steiner had suggested that the copper crystallisation (after E. Pfeiffer) and capillary method (after WALA) could be used to investigate the expressions of the (invisible) etheric world. At the Louis Bolk Institute, the water drop method (after Schwenk) was part of the research in water quality. Although I did not practise any of these methods by myself, there was an intensive exchange of knowledge between the different departments of the institute.

At that time, there was a strong vision within the agricultural department on how to develop knowledge coming from and together with agricultural practitioners (Anonymous, 1985). We not only wanted to develop scientific insights, we also wanted to develop farmers' independence. This had to be done in such a way that this knowledge is connected with everyday farm practice. We were conscious that a lot of knowledge is hidden within everyday experiences, so-called tacit knowledge. The character of this knowledge is holistic on the one hand and adequate, context-related on the other. Cooperation and interaction with individual farmers and farmer groups finally led to the implementation of a bottom-up approach in several research projects. From that moment on I was closely connected with organic dairy farmers and new projects were born based on the intentions of farmers who were considered to be pioneers. In 1999, a handbook was published about this methodology in Dutch, entitled 'The farmer as an experiential scientist' (Baars & De Vries, 1999). In 2002, a scientific reflection on this way of working took place and I completed my thesis in English about the scientific approach practised at the Louis Bolk Institute. The methodology was characterised as 'experiential science', a term used explicitly to emphasise the differences with experimental knowledge (Baars, 2002). The development and exploration of experiential science was the fourth paradigmatic change in my scientific career. My former colleague Albert de Vries completed his thesis in 2005, in which he further developed the knowledge gathered during our own daily work (De Vries, 2005).

Experiential science is based on the unique knowledge gathered by pioneering farmers. A case study evaluation is the basis of this method and a strong scientific element of the methodology is the so-called pattern recognition done by experts (Kiene, 1998). I have shown, that action, feelings and thinking are part of the knowledge process (Baars, 2002). Experiential knowledge and insights are primarily based on farmers' actions and the reflection on the learning process during action rather than on experimental deduction. Over a 20-year period, a methodology has been created based on intensive cooperation between single farmers or farmer groups and scientists/advisors. In this cooperation all members were equal, each bringing in their specific, but different observations and knowledge. The method is not hierarchical or top-down out of the ivory tower of science. Insights gathered from experiential knowledge are based on the reflective observation skills of these experienced practitioners.

This experiential knowledge is not only holistic, but also adequate. As in formal science, experienced practitioners develop valid knowledge (Snoek, 1993) and in new, unknown situations they have a capacity to integrate for diagnosis ('knowing what') and the right action, needed at a specific moment ('knowing that'). These human skills and capacities have to do with the right side of the brain processes, where experienced people only need fragmental information to recognise and understand a situation (Servan-Schreiber, 2005). The end of a (re)search process of professional agricultural practitioners is a 'system that works' for their specific situation and in their context (Röling, 2000). Rather than hard science, the interest is present in the 'soft side of reality' (after Röling, 1997). The systemic development of a new practice is based on subsystems, which together form the new management. These subsystems, which are developed in a stepwise fashion, can be described as a set of 'novelties' (Swagemakers, 2002) to show the innovative side of this knowledge-in-action.

University graduates receive the title Master of Science (MSc). To develop experiential knowledge in a scientific way, it was clear that learning during action is based on other preconditions than theoretical learning. In a moment of intuition, the expression 'Masters in Action (MAc)' arose, which highlights the contrast between the two sorts of education: education between first-hand learning in practice and second-hand learning in theory. For me this action-knowledge has become as if not more important than formal scientific knowledge. In daily practice this experiential method of evaluating and learning from practical experiences of professionals can be combined with on-farm experimentation (Baars, 2002).

Since 2000, researchers and advisors inside and outside the Louis Bolk Institute have been trained to use these experiential skills in practice. An important project involving this approach is 'Bioveem', an inter- and transdisciplinary project which I present below (Baars et al., 2005). From a methodological point of view, the project is an enlargement of the handbook written about experiential science (Baars & De Vries,1999).

In summary: I mentioned four paradigmatic changes, which affected the way I am observing and understanding the world nowadays. These paradigmatic changes affected my vision on education and research:

- Systems, ecological relationships and systemic solutions came into my consciousness.
- In Goethean sciences a holistic research method was presented.
- Spirit became part of my world in such a way that it was omnipresent.
- In experiential science my respect for the farmer and the farmer's insights was strengthened and it became clear that this type of 'knowledge was in action'.

Philosophical reflections

In my thesis (Baars, 2002) I use a four-quadrant matrix (Figure 1; after Miller, 1985; Bawden, 1997 and Röling, 2000) to explain the different steps of paradigmatic change (Figure 2). The matrix reflects two polarities derived from the philosophy of science:

- The objective, positivistic approach to knowledge, versus the subjective, constructed one. This contrast reflects different epistemologies in the way we try to understand the world;
- The holistic versus the reductionist approach to observation, thinking and explanation.

	Constructivism (subjectivism)	**Positivism (objectivism)**
Holism	3. HOLO-CENTRIC	2. ECO-CENTRIC
Reductionism	4. EGO-CENTRIC	1. TECHNO-CENTRIC

Figure 1 Matrix to distinguish between different scientific paradigms

The paradigmatic steps I have gone through correspond with the description of the changes in the scientific community, where the integration of natural sciences and social sciences are discussed (Röling, 2000). Starting in the worldview of quadrant 1, my education in ecology made me conscious of systemic knowledge and process development presented in quadrant 2. I crossed the border that separates positivism and constructivism, when I encountered Goethean science (Quadrant 3). Anthroposophy can be seen as a step into the 4th quadrant. In a paper about the different ways to solve a pest problem in agriculture, these four quadrants were used to distinguish between the possible approaches. Bawden (1995) mentioned the solution 'praying' as the action for this 4th quadrant. Anthroposophy might correspond with this solution, because religious aspects are present in anthroposophy from an atheistic and materialistic worldview, which dominates scientific belief.

However, this stepwise inner development does not show how I have worked out the methodology used in experiential science in this matrix. In my thesis, I positioned the starting point of experiential science in this 4th quadrant (Figure 2). My motivation to start in a quadrant that combines reductionism and constructivism, was oriented on the action side of experiential science. The basics of experiential science are adequate and well-timed actions; this is reductionist, because it is an answer only for this particular situation. At the same time, the action is constructivist, because it can only be made by the professional who is present and responsible for the situation. In the final description of how the methodological steps in experiential science were carried out in practice, I have shown that experiential science will start in quadrant 4 (Figure 3; the constructivist, adequate action). Before you decide to support the action research by any experiment (quadrant 1), you have to be aware of two types of context in relation to the farmer's action: the biographical context of the farmer (quadrant 3) and the physical restrictions and challenges of his specific farm ecosystem (quadrant 2). If you have investigated and described these two elements, on-farm experimentation (quadrant 1: on-farm action research) can be helpful to bring new insights. The process, however, is cyclical. Due to actions and reflections on the one hand and on-farm experiments on the other, insight into the specificity of the farm grows. Therefore, I described a repeating cycle of these steps as the essence of the experiential process, where both farmer and scientist are involved. This process of actions, reflections and experimentation will come to an end, once the farmer has developed a new 'system that works'. This is a new set of management actions that fit in a new farming situation, and at this point, the farmer's search process for this specific topic stops. The new insights can be described (Baars, 2002) and if records are kept of the steps of development, these results can be published in a peer-reviewed setting (Baars & Veltman, 2003).

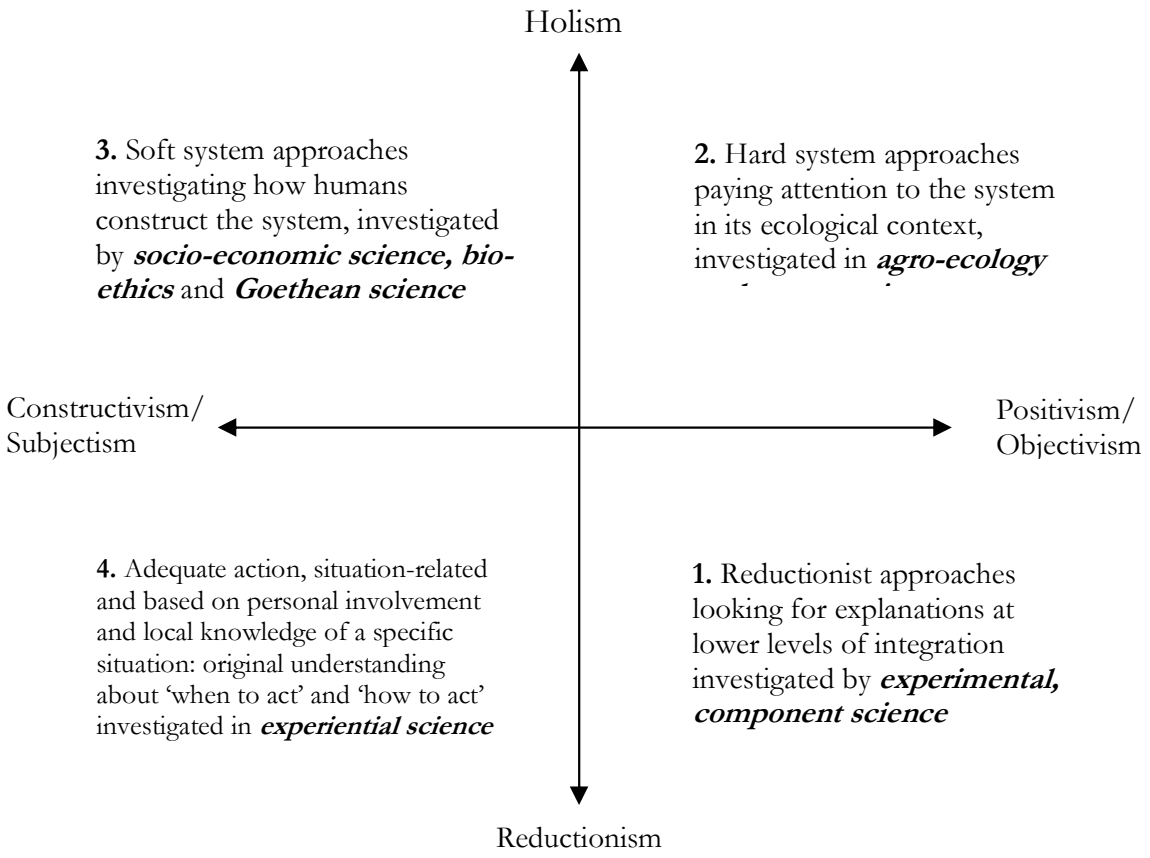

Figure 2 Scientific approaches based on the Four-Quadrant matrix

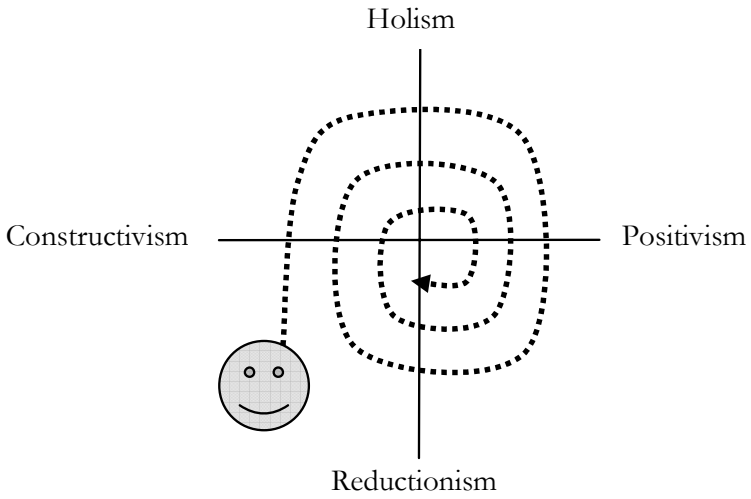

Figure 3 The steps undertaken in experiential science within the framework of reductionist versus holistic science approaches (vertical axis) and of the constructed world versus the objective world (horizontal axis)

In the next section I discuss the consequences of these paradigm changes for teaching and research activities. Finally, I describe the Bioveem project, an outcome of a transdisciplinary experiential research project with pioneering organic dairy farmers. I regard the project as an example of how I would like to integrate farmers' experiences and scientific knowledge in scientific cooperation.

Teaching activities at the University of Kassel

Although for a lot of people in the outside world biodynamic farming is connected with knowledge about the relationship between the stars and moon and plant development, or the specific influence of the so-called biodynamic preparations on the development of soil and plants, I am convinced that biodynamics cannot be understood without a good knowledge of anthroposophy. To become an adequate biodynamic trainee it is not only important to gather knowledge about specific biodynamic themes, it is also important to learn how you can investigate the living world by training your own holistic and spiritual capacities and skills to investigate and observe the world. Students therefore should learn how a holistic worldview can be accompanied by holistic teaching methods.

A teaching programme has been developed, based on the two approaches mentioned above: Goethean sciences (Bockemühl, 1980) and experiential sciences (Baars, 2002). Goethean science is used to train the students in scientific holism, but this is isolated from the farm reality. Goethean science is not connected with actions, but is a method for holistic understanding and thinking. Goethean sciences respect the entity of the object of research. The basic elements of this method are the comparison in time and space of the observed in its natural development, the inner imagination of these shapes and development, and the reading of its gesture (Bockemühl, 1977). These observational and comparative methods are used to understand the otherness. The Goethean method is empathic. Much attention is paid to learning about the natural growth and development of living organisms in their own specific environment. A second step of this methodology is to understand the 'inner gesture' of the observed, its expression. Through Goethean science, researchers have developed new holistic insights concerning for instance landscape development, plant breeding and evolution.

In contrast, experiential science starts in real life reality and its knowledge is always connected with doing the 'right' actions in a specific situation. In experiential science, the personal on-farm experience of farmers is as important as the so-thought objective knowledge gathered from scientific experimentation. As a matter of principle, farmers have to reconcile holism and reductionism. Through reflections on their daily actions, they build up inner holistic images of their cultivated plants and their farm animals, as in Goethean science. Like all experienced practitioners in other professions, farmers use these holistic images to make decisions in new and unknown circumstances: at the right time and in the right place. Pattern recognition is an important element of this type of experiential knowing and acting (Kiene, 1998).

I realise that a lot of what I have learned in the last twenty years and what I am now integrating in a research and teaching programme, has to do with the understanding of and learning from 'the soft side of land' (after Röling, 1997).

Traditional science has taught us how to tackle the measurable side of the world, whereas Goethean science and experiential science open up methods to train the qualitative, constructive or personal side of the world.

For my teaching programme at the University of Kassel therefore the following elements are important:

- Training of the observation skills. Seeing is something else than observing and most people are rather lazy observers. Their brain fills in what they assume is there in terms of old imaginings, instead of using different perspectives to build up a holistic and real-life picture of the observed. Repeated observations in time and space are used to build up this picture. Comparative studies between related plants and animals are used to become aware of differences and of the specific elements of the single species or example.
- Use of arts. Goethean science cannot be developed without the arts, just as the left side of the brain cannot function without the right hemisphere. Eurhythmics is an art that makes people aware of movements rather than of fixed forms only. Moving is the basis of change and of being aware of the developing process. Simple drawing techniques (plants) and modelling techniques (animals) are used to look at the expression of the observed.
- Training of twelve rather than five senses. In anthroposophy people assume there are more than the traditional five senses. The so-called 'sixth sense' corresponding with our feelings, is much heightened in anthroposophy. Due to the awareness of these 'new' senses it is possible to discuss what lies behind the gap which exists between positivism and constructivism. Meditation is considered part of education as well. Students are shown that one can train the subjective areas of the body connected with feelings, expressions, meanings, intuitions and other inner imaginings. Steiner introduces for instance the moving sense (German: *Bewegungs-* or *Eigenbewegungssinn*) and the thinking sense (German: *Gedanken-* or *Denksinn*). These senses are the tools for understanding the steps made into the 'subjective' world.
- Learning from real-life farm situations in combination with a focus on challenges rather than on an attitude of reductionist and symptomatic problem-solving. Successful practitioners are visited, their situation is analysed and their learning process and biography are understood.
- Training in the scientific evaluation of pattern recognition. Pattern recognition is the key for experiential science. Different forms of pattern recognition are distinguished and taught.
- Training of distance – connection. Students are trained to be aware of their connectiveness rather than to maintain a (scientific) distance towards the observed. How can you be involved with the other without losing your objectiveness?
- Being aware of the philosophical implications of Goethean science and experiential science. Students should be aware that the chasm that ultimately separates the different scientific approaches has to do with the non-acceptance of ontological holism in the traditional scientific community.

Research activities at the University of Kassel

Before I describe my own research topics and the research methodologies used, I will first describe in general how anthroposophical researchers deal with science and anthroposophy. In the anthroposophical scientific community, one can distinguish at least five different scientific approaches:

- The themes of interest are based on anthroposophical information from Steiner's work (In German: *Angaben*); however the scientific methods used can be conventional or traditional. So, randomised split plot or randomised clinical trials and double-blind situations are used to test the outcomes of a hypothesis. A lot of scientific work on the biodynamic preparations, for instance, is done on small-scale plots or field trials (König, 1999). Behind this methodological choice is the acceptance of anthroposophical insights in the traditional scientific world. Biodynamics has to be proven 'evidence-based practice'.
- The scientific methods used are based on holistic insights and, in the way they are used, they will reconcile holism and reductionism. These methods are directly connected with the observed (Goethean science, experiential science). Within the anthroposophical movement I feel a principal difference between the two methods. Goethean science is an accepted method, initiated by Steiner. Goethean science focuses on the 'right and holistic' understanding of the world. In Goethean science, the most impressive work in the last decades has been done by people like J. Bockemühl, W. Schad, T. Goebel and A. Suchantke. In farm practice, the Goethean method is also used in the understanding of the biodynamic preparations or to make new steps in landscape development (Baars and Van Gelder, 1994). Experiential science was not initiated by Steiner, however it has developed in strong connection with anthroposophy. Experiential science focuses much more on doing the *'right actions'* in the world rather than developing the *'right thinking'* gathered by Goethean science. However, the right actions cannot be taken without a holistic understanding of the world, which has been developed in Goethean science. Recently De Vries (2004) developed new steps in experiential science. Experiential science is based on the insights of professional experts, such as farmers or social workers. Van der Laan (2003) calls this type of insight 'practice-based evidence' and the learning process is based on casuistry and reflection on the evidence.
- The scientific methods used are anthroposophical and holistic. The background of new methods such as copper crystallisation and water drop imaging are completely based on the work of Steiner, who had clear views on the etheric, inspirational world.
- Rewriting or understanding the phenomena observed in the world based on anthroposophical insight. This type of work resembles a literature review. Scientists are fairly aware of the otherness of the anthroposophical worldview and use this insight to show other connections in the world. The Louis Bolk Institute has produced a book series, called Bolk Companions, in which medical doctors 'rewrite' human physiology, embryology, etc., based on Goethean and anthroposophical insights. Another example is Wolfgang Schad, a biologist who described the inner connectedness of mammals based on the threefoldness of

man. It is not the mammals that have changed, but our opinion on how they are connected. The idea of threefoldness is one of the basics of anthroposophy: Steiner describes how action, feeling and thinking are the three elements of our soul. This trinity is very often distinguished to separate the surrounding world.

- Discussing the basics of science philosophy. This work is often combined with one of the above entries to broaden scientific approaches. Recently the Louis Bolk Institute organised the scientific conference, Such Is Life (Baars and Baars, 2006 in prep), to stimulate awareness of the relationship between new methodologies and its philosophical implications.

At the University of Kassel it is my job to build up a research programme for the Department of Biodynamic Agriculture. The main methodological mix that will be used in my research programme is based on the first three points. The main themes will be: the differentiation of the Demeter[1] milk quality and trading in this; growth and development of young stock and in-herd calf-rearing and research on life forces and their validation. Independent of the themes, I find it important that all scientific work is connected with the farmers' knowledge and insights, and is evaluated in a participatory way.

Since participatory research is a central element in my research approach, I now highlight some essentials of this method based on the Bioveem project, which was one of the last multi- and transdisciplinary projects I headed at the Louis Bolk Institute (see also Baars, 2002; Baars et al., 2005; Iepema et al., in prep).

Case project: Bioveem

The Bioveem project is presented as an example of an approach that links experiential science, bottom-up learning, system-prototyping, farmer-to-farmer learning, multi- and trans-disciplinary research and on-farm research. Specific attention is paid to each farmer's worldview in biographical interviews. The first goal of the project was 'system development based on bottom-up choices of the farm manager'. Bioveem had the following characteristics:

- Instead of a selected set of disciplines, in principle all disciplines should collaborate in the project in a transdisciplinary way.
- The project is farmer-oriented and three groups of farmers took part in the project:
  - Innovative farmers who act as pioneering entrepreneurs in specific areas of organic farming. Their farms are treated as experimental stations (see Box 1).
  - Optimising farmers whose farms are used as a testing ground for existing knowledge in organic dairy farming.
  - Farmers in conversion from conventional to organic farming.
- Only themes of interest were formulated, and the details of the project were initially left blank. Only after the farms had been selected could research projects be implemented.

[1] Biodynamic certification.

- A link was made with the extension service, DLV. One of its tasks was to advise and support each farmer in specific data collection, if necessary.

The following mission was formulated: 'Dairy farmers, researchers and advisors combine their specific knowledge, visions and skills. Together they deliver a unique contribution to the strengthening, development and expansion of organic dairy farming in the Netherlands.' Bioveem was an extension of the idea of farm-prototyping based on pilot farms. In the Bioveem project, the optimisation group of farmers is used for the purpose of prototyping desirable future organic farming systems. This group is used to demonstrate existing knowledge and farmers are assisted by researchers and extension workers in adapting existing knowledge to their specific situations. However, we have added an innovative group to the project, which consists of farmers who go in search voluntarily of future developments of knowledge that does not yet exist. The basic requirement for joining the innovative group is personal involvement of an individual farmer with a specific type of organic farm. Action research and mutual learning are the methodologies that accompany this group. The whole innovative farmers' group acts as an interactive 'research-group' at the same level as the research farms for applied research. New topics will be tested and developed within specific farming circumstances. In bottom-up co-operation between farmers and scientists, these farmers explore the limits of the diversity of farming systems (see Box 1).

Box 1 Innovative farms/pioneers in the Bioveem project

Ten to fifteen innovative farms with different farm and soil types, distributed across the country have been selected. This group comprises dairy farmers who are consciously committed to organic agriculture. They have been operating organically for some time, have overcome the teething problems and are now considering how to proceed. The direction of development varies between participants, depending on their personal management style. The farmer chooses the themes to be developed and the desired outcomes in consultation with the project team. Personal involvement provides an incentive to push back frontiers. The farmer is prepared to take risks. Each farmer in this group adds a unique element to the group as a whole in terms of operational style, challenges or objectives.

The objective is to open up and generate new knowledge and to make the individual's search for solutions a conscious process, which can then be communicated to others. Monitoring and analysis provide insight into the effects of the farmer's actions. The guidance provided is individual and characterised as a 'guided trial-and-error search process'. The farmer's knowledge and experience are an essential part of the operation. The researcher is detached and on equal terms with the farmer. The farmer is explicitly encouraged to develop methodologies by experimenting in the farm context. Exchange of experience among the participants in this group is important. The specific new insights obtained are developed within the context of a specific farm and should therefore be considered as hypotheses or principles rather than as transferable concepts. The next step is to further quantify and model the new insight (if necessary on experimental farms) and to test it on the optimisation farms.

The themes covered include farm quality and business development; farm economics; chain development; milk product quality; manure application, soil fertility and crop rotation; cultivation of grass and fodder crops; animal feed, inter-sectoral cooperation, livestock breeding; animal health and fertility; environment and nature. They involved

trans-disciplinary cooperation within a number of agricultural organisations and research institutes.

Participatory action research and experiential learning of pioneering farmers were integrated into a larger setting within the project. Each of the pioneering farms acts as an experimental station. The positive side of this approach is that we focus on a diversity of farming systems and other farmers can recognise their own style of farming in one of these pioneers. Therefore, the variety of chosen pioneering farming systems will be as large as possible. Each pioneering farming system has its own context, goals and restrictions, which will be described in the yearly monitoring of facts and figures about the farm. In this praxis, the pioneering group of farms together acts as a 'garden' for the development of future organic farming (Figure 4). Each of these pioneering farms can be further improved, depending on the goals and possibilities of each individual farmer (bottom-up). This group of diverse farm practices can be used by researchers who are developing different farm-related themes together with an individual farmer or a farmers' group.

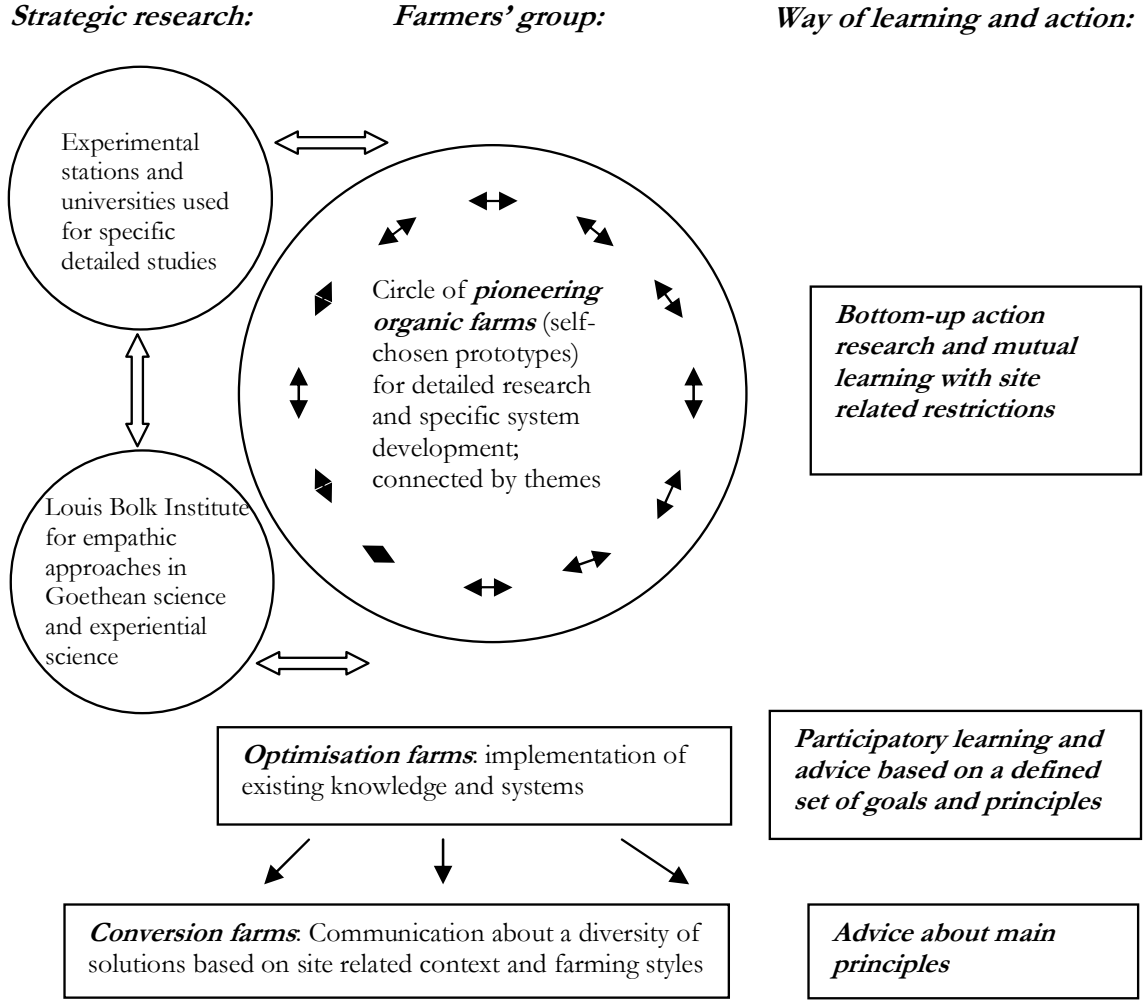

Figure 4 Initial R&D model including extension in the BIOVEEM project and the assumed relation to strategic research, which can be implemented by different research organisations. The pioneering farmers are considered as self-chosen prototypes exploring new areas of interest. The optimisation farms are considered as 'future good farm practice', based on existing knowledge and experience showing the level of knowledge about organic dairying. The conversion farms receive general advice.

Concluding remarks

Within agriculture, the practice of biodynamic farming shows the greatest contrast to conventional farm practices. The top-down scientification of conventional farming has created an enormous uniformity in farming systems, breeds and races, water tables and landscapes, but also in on-farm management (Van der Ploeg, 1987). Due to the contrast mentioned, generic solutions do not exist in biodynamic farming, and different science and education is needed (Baars, 2002). Tools like artificial fertilisers, pesticides and allopathic medication of farm animals is not used. Therefore, it makes sense in biodynamic farming to start with knowledge gathered from 'practice-based evidence' rather than to push biodynamic farming into the direction of an 'evidence-based practice' (Van der Laan, 2003). Characteristics of a new programme in science and education in biodynamic agriculture are: casuistic rather than generalist, holistic rather than reductionist and constructivist rather than positivist, involving real-world settings rather than isolated experimental situations. Goethean science and experiential science are important methods for this training programme. In research projects, the competences of professional farmers and their expert knowledge form a crucial starting point for the development of insight into biodynamic farming systems.

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