Chapter 2

Fundamentals of Organic Agriculture – Past and Present

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Abstract Organic agriculture can be traced back to the early 20th century, initiated by the Austrian spiritual philosopher Rudolf Steiner. It was later diversified by a number of key people, and more recent versions are guided by principles issued by the International Federation of Organic Agricultural Movements (IFOAM), founded in 1972. Organic practices were built upon the life philosophies and convictions of the founders regarding how to perceive nature. Today, those original views and ideas are considered as history. However, to understand the principles and opinions of modern organic agriculture, such as the exclusion of water-soluble inorganic fertilisers, we analysed the original ideas and arguments of the founders, who shared the common principle of relying on natural processes and methods, seen as a prerequisite for human health. For example, the British agriculturalist Sir Albert Howard, who together with Lady Eve Balfour founded the British Soil Association, claimed that healthy soils are the basis for human health on earth. In their view, healthy soils could only be obtained if the organic matter content was increased or at least maintained. Later, the German physician and microbiologist Hans-Peter Rusch together with the Swiss biologists Hans and Maria Müller, focused on applying natural principles in agriculture, driven by the conviction that nature is our master and always superior. Even though these early ideas have been abandoned or modified in modern organic agriculture, the principle of the founders regarding exclusion of synthetic compounds (fertilisers and pesticides) is still the main driver for choosing crops and pest control methods.

Keywords Ethics · Founders · History · Life philosophy · Nature philosophy · Theories · E. Balfour · A. Howard · H-P. Rusch · R. Steiner

1. INTRODUCTION

In this chapter, the thinking and arguments of the founders of organic agriculture are analysed. The origins and characteristics of the different schools of organic agriculture are described and the theories and statements of the founders are discussed and evaluated. Furthermore, to get an in-depth picture of the principles of organic agriculture, it is useful to be familiar with the philosophies of life in which the founders were interested, as these influenced their perception of nature and their views on human activities. Only a few scientifically-based analyses of organic agriculture theories have been performed (Jansson, 1948; Kirchmann, 1994).

We want to emphasise that we acknowledge the sincerity and well-minded intentions of the founders and their followers. Many organic farmers are highly skilled and successful experts. Our analysis is solely focused on the roots of organic agriculture and our perspective is limited to methods developed in Europe. Asian forms of organic agriculture such as natural farming according to Buddhism by the Japanese Masanobu Fukuoka (1978; 1989; 1991) or Zen macrobiotic farming based on the diet of George Oshawa (Oshawa and Dufty, 2002) are not considered in this overview.

2. BRIEF HISTORY OF THE DEVELOPMENT OF ORGANIC AGRICULTURE

The development of organic agriculture dates back to the beginning of the 20th century summarised in Table 1. It started as a reaction against industrialization of agriculture and was a response to concerns over the use of mineral fertilisers and pesticides (Merrill, 1983; Conford, 2001). Critics pointed out the unnaturalness of these compounds and regarded their use as a wrong way to produce food. The message was that organic practices have been around for a several thousand years and that maintenance of these practices is a reliable way to achieve healthy food products. One of the forerunners of organic agriculture was the 'life reform movement' (Lebensreform Bewegung) in Germany in the 1920s, which acted against urbanisation and industrialisation, idealising vegetarian food, self-sufficiency, natural medicine, allotment gardens, physical outdoor work and all kinds of nature conservation (Vogt, 2001). In 1927/28, the first 'organic' organisation – Arbeitsgemeinschaft Natürlicher Landbau und Siedlung (Community of Natural Farming and Settlement) – was founded with the focus on fruit and vegetable production without artificial fertilisers and pesticides.

The first distinct form of organic agriculture was introduced in 1924 by the Austrian Rudolf Steiner, forming the basis for bio-dynamic farming (Steiner, 1924). Steiner gave a series of lectures entitled '*Geisteswissenschaftliche Grundlagen zum Gedeihen der Landwirtschaft*' (Spiritual foundations for the renewal of agriculture), with instructions on how to produce organic food supplying spiritual forces to mankind.

The 1940s brought the next wave of organic pioneers, with Lady Eve Balfour (widow of the British Prime Minister Arthur James Balfour) and Sir Albert Howard as prominent figures in the United Kingdom (Howard, 1940; 1947). In 1943, Lady Balfour published a highly influential book called '*The Living Soil*' in which she pointed out the importance of a healthy soil and the nutritional superiority of organically grown food. In 1946, Balfour and Howard founded the British Soil Association.

In the 1950s, the Swiss couple Hans and Maria Müller developed biological-organic farming methods, encouraged by the bio-dynamic agriculture of Steiner. In 1968, the German physician Hans-Peter Rusch provided the basis for biological organic agriculture in his book entitled '*Bodenfruchtbarkeit*' (Soil fertility), stressing the recognition of biological wholeness and a holistic view on food production and nature (Rusch, 1978).

In 1972, during an organic agriculture congress in Versailles (France), five organic organisations founded a global organisation called the International Federation of Organic Agriculture Movements (IFOAM), which since then has promoted its worldwide adoption, set standards, drawn up certification procedures etc.

Although some environmental problems as a result of the industrialisation of societies had already been identified, the breakthrough in broad environmental consciousness in the 1960s enabled advocates of organic agriculture to advance their argumentation. Organic agriculture methods were

Table 1. Brief overview of the development of European organic agriculture

Movements	Focus
Early 1900s -1960: Reform movement	
1924 Introduction of bio-dynamic farming	Spiritual food production
1946 Foundation of the Soil Association	Health food production
1960-1990: Environmental movement	
1962 Publication of 'Silent Spring' by Carson	Against pesticides and pro-environment
1968 Introduction of bio-organic farming	Holistic food production
1972 Foundation of International Federation of Organic Agriculture Movements (IFOAM)	Standardisation, lobbying for world-wide adaption Marketing environmental superiority
1980s Definition as 'eco-agriculture'	
Since 1990: Political movement	
Governmental support	Promotion, subsidies, funding of research, etc.

now also presented as a solution to the environmental problems caused by modern agriculture. The book '*Silent Spring*' by Carson in 1962 was a keystone pointing out the detrimental effects of widespread pesticide use poisoning nature. Later, the 'Club of Rome' book '*Limits to Growth*' by Meadows et al. (1972) focused on population growth and resource depletion, including the environmental consequences of modern agriculture. The exclusion of pesticides and the additional elimination of limited resources such as phosphates and fossil fuels for fertiliser production, respectively, were now used as arguments for the superiority of organic agriculture.

Water pollution by agriculture through nutrient leaching followed by algal blooms was observed during the 1970s (e.g. Ahl and Odén, 1972). Earlier emphasis by organic agriculture organisations on the better quality of organic food and the benefits of organic agriculture for soil (Koepf et al., 1976; Dloughý, 1981) was now complemented by reports pointing out the benefit of this type of agriculture for the environment (e.g. Koepf, 1973). In the early 1980s, eutrophication of lakes and rivers was intensively reported in Europe and nutrient leaching from agriculture was identified as being a main cause. Somewhat later, the advocates of organic agriculture used this opportunity to claim that organic agriculture would be able to reduce N leaching (Granstedt, 1990; Kristensen et al., 1995).

The period between 1980 and 1990 saw a great revival in organic agriculture, initiated by environmental problems caused by modern agricultural practices. Organic agriculture was attributed to be sustainable and environmentally friendly and was redefined as 'ecological' agriculture or 'eco-agriculture'. The image of organic agriculture as a problem-solver attracted much larger groups of 'green' supporters, who made a political case for public support.

Since 1990, 'green' and other political parties have initiated a number of activities promoting organic agriculture, such as ear-marked research grants, creation of research foundations and funding of university departments of organic agriculture. Furthermore, subsidies for organic production, educational programmes and extension services for organic agriculture were established. In several countries in Europe, organic agriculture has grown in the past 20 years to be a significant sector within agricultural production, whereas in other countries it has remained at a relatively low level. In Austria, for example, 200 farms were managed according to organic principles in 1980 and 18 360 in 2001, the latter accounting for approximately 25% of Austrian arable land (Freyer et al., 2001). In Sweden, a political programme with the aim of increasing organic production to cover 20% of farmland and to encourage the consumption of organically grown food in schools, hospitals, residential care homes etc. has recently been proposed. Today, organic agriculture is a mainstream interest in Western societies, although it has been criticised for not taking into account contradictory evidence regarding some of its claims (Avery, 2000; Tinker, 2000; Trewavas, 2004; Taverne, 2005; Avery, 2006).

3. THE SCHOOLS OF ORGANIC AGRICULTURE

3.1. Biological Dynamic Agriculture (Rudolf Steiner)

The Austrian Dr Phil Rudolf Steiner (1861-1925), who taught mysticism and esoteric wisdom, created a spiritual system called anthroposophy, a variant of theosophy. He applied his teachings to a wide range of areas in society, e.g. arts and architecture, medicine, religion, pedagogics and also agriculture. Biological dynamic (biodynamic) agriculture builds upon Steiner's lectures during a one-week agricultural course in 1924 in Koberwitz (now Wroclaw), Poland (Steiner, 1924), when he taught a group of followers on considerations of spiritual matters in agriculture.

Steiner wanted to change agriculture and introduced new practices in accordance with his supernatural insights. He gave detailed instructions on non-visible matter, how it acts in soil, crops and animals and how to affect and control the 'forces' related to such matter. The text of his lectures provides the core information for current biodynamic farming and can be seen as the basis for the first distinct form of organic agriculture.

Steiner was worried about food quality and the effect of inorganic fertilisers in decreasing crop quality. For example, he taught that agricultural products would degenerate so that they could not be used as food for humans by the end of the century "*....die Produkte so degeneriert sein werden, dass sie noch im Laufe dieses Jahrhunderts nicht mehr zur Nahrung der Menschen dienen können*" (Steiner, 1924 p. 12). Furthermore, he stated that nobody could know whether mineral fertilisers would lead to a significant degeneration in the quality of agricultural products "*Es weiss zum Beispiel kein Mensch heute, dass alle die mineralischen Dungarten gerade diejeningen sind, die zu dieser Degenerierung, von der ich gesprochen habe, zu diesem Schlechterwerden der landwirtschaftlichen Produkte das Wesentliche beitragen*" (ibid. p. 20). He claimed that plants are stimulated by wateriness through inorganic fertilisers; they are not stimulated by the living soil "*Daher werden Ihnen Pflanzen, welche unter dem Einfluss irgendwelchen mineralischen Düngern stehen, ein solches Wachstum zeigen, das verrät, wie es nur unterstützt wird von angeregter Wässrigkeit, nicht von lebendiger Erdigkeit*" (ibid. p. 94). Furthermore, Steiner pointed out that this is a general law "*Denn jeder mineralische Dünger bewirkt, dass nach einiger Zeit dasjeninge, was auf den Feldern erzeugt wird, die mit ihm gedüngt werden, an Nährwert verlieren. Das ist ein ganz allgemeines Gesetz*" (ibid. p. 176).

However, Steiner did not teach common crop quality criteria such as mineral, protein, carbohydrate or vitamin content or taste. Instead, he instructed on how to manufacture eight different compounds consisting of mixtures of minerals, wild plants and animal organs. Two compounds are aimed at affecting supernatural crop qualities enabling the transfer of 'forces' into soil (humus compound) and crops (silica compound). Six compounds are used for the preparation of animal manure (compost compounds) also transferring 'forces' via manure into soils and crops. For example, cow manure and powered silica should be placed into cow horns (humus and silica compound) to accumulate 'forces'. Thereafter, these materials must be highly diluted with water through both clockwise and counter-clockwise spinning and then sprayed on crops and soil. The 'forces' accumulated in the cow horns will thereby enable a balanced exchange of terrestrial and cosmic forces in fields. Steiner also stated that sowing or planting of crops should be carried out according to astrological principles.

Steiner's supernatural views on 'radiation' and flows of 'forces' were not derived from natural science but gained from views and inspiration received during mental exercises. The 'forces' Steiner instructed on are unknown to science. However, this is not a proof of their non-existence. On the other hand, there are other strong indications that Steiner's scientific knowledge was limited, as exemplified by the following quotes. Steiner talked about a secret chemistry in organic processes. For example, he claimed that potassium is transformed into nitrogen and even lime "*Ich habe fortwährend davon gesprochen, …weil nämlich im organischen Process eine geheime Allchemie liegt, die zum Beispiel das Kali, wenn es nur in der richtigen Weise drin arbeitet, wirklich in Stickstoff umsetzt und sogar den Kalk, wenn der richtig arbeitet, wirklich in Stickstoff umsetzt* " (Steiner, 1924 p. 136). According to current scientific knowledge, the energy in biological systems is too low to drive nuclear reactions and transmute elements. In addition, the following quote also reveals Steiner's poor knowledge in the field of chemistry, since he believed that silica is transformed into another element of the utmost importance in organisms "*Das Silizium wiederum wird umgewandelt im Organismus in einen Stoff, der von ausserordentlicher Wichtigkeit ist, der gegenwärtig unter den chemischen Elementen überhaupt nicht aufgezählt wird*" (ibid. p. 137). Even in 1924, it was common scientific knowledge that there is no element transmutation in biological systems.

The following quotes expose Steiner's lack of understanding of science. He lectured on the effect of wild plants that were used for the preparation of his biodynamic compounds. The stinging nettle (*Urtica dioica*) compound makes the soil reasonable "Es *ist wirklich etwas wie eine Durchvernünftigung des Bodens, was man durch diesen Zusatz von Urtica dioica wird bewirken können*" (ibid. p. 133). Dandelion (*Taraxacum vulgare*) is the intermediary between the homeopathically distributed silica in the cosmos and the silica really needed in the whole area "*Der gelbe Löwenzahn, wo er in einer Gegend wächst, ist …. der Vermittler zwischen der im Kosmos fein homoöpathisch verteilten Kieselsäure und demjeningen, was als Kieselsäure eigentlich gebraucht wird über die ganze Gegend hin*" (ibid. p. 137).

Steiner looked upon each farm as a closed entity and as a self-sustaining unit. He said that any import to the farm should be seen as a cure for a sick farm "*Landwirtschaft … kann als eine wirklich geschlossene Individualität aufgefasst werden. Was in die Landwirtschaft hereingebracht wird an Düngemitteln und ählichem von auswärts, das müsste in einer ideal gestalteten Landwirtschaft angesehen werden schon als ein Heilmittel für eine erkrankte Landwirtschaft*" (ibid. p. 42). The idea of self-sustaining farms is attractive in many ways as it excludes long-distance transport of animal feedstuffs, purchase of fertilisers, import of animals etc. and only presupposes sale of food products. However, in reality this is difficult to achieve. It is well-known that sale of products from a farm means a significant export of nutrients through food products, leaching and other losses, which will result in nutrient depletion in soil over time. It is impossible to maintain soil fertility and high yields over time through an internal recirculation of manure only. On the other hand, Steiner prohibited the return of nutrients present in toilet wastes. A more thorough analysis of biodynamic agriculture has been published earlier (Kirchmann, 1994).

In summary, Steiner stated that behind visible nature there is a supernatural, spiritual world. According to him, organisms have spiritual bodies (e.g. physical, ethereal and astral) interacting with each other in interwoven flows either emitting or absorbing 'forces'. Spiritual energies are regarded to fill and pervade all things. The specific biodynamic compounds introduced by Steiner should supply soil and plants with 'forces' in order to control the absorbance or emanation of 'terrestrial and cosmic forces'. He wanted to influence life through control of spiritual forces, presupposing their existence in physical matter. There is one central reason why Steiner had an interest in controlling 'spiritual powers' in agriculture production. He wanted to show how to produce food enriched with 'spiritual powers' that could help mankind to develop spiritually and reach complete intuition. In order to improve karma, overcome evil and finally reach a complete stage of spiritual enlightenment and liberation, humans need to refine their soul and develop spiritually. For a true follower of Steiner, the use of biodynamic compounds is a way to help mankind to reach this goal.

Steiner wrote an additional gospel text to complement the New Testament (Steiner, 1913). He described Christ as being the spirit of the sun (sun logos). He believed that Earth and Sun were unified when Christ was born on Earth. Furthermore, when the blood of Christ dropped onto the earth at Golgotha, Earth actually became the body of Christ. As a consequence, Earth has become holy and nature has received forces for salvation. This may explain why Steiner maintained that only natural means and methods are to be used and why inorganic fertilisers and synthetic pesticides need to be excluded, as only natural products contain curing and saving forces for mankind.

One may conclude that the exclusion of synthetic fertilisers and pesticides in biodynamic production is not motivated by environmental concerns, resource conservation or improvement of biochemical crop quality properties. Steiner did not instruct on how to improve soil fertility or nutrient recycling in society, reduce nutrient leaching from soil, or decrease ammonia volatilisation from composting. He taught how to channel 'forces' into food as an essential contribution to the spiritual development of mankind. His ideas about a supernatural world, on which he gave instructions, are unknown to science.

3.2. Organic Agriculture (Eve Balfour and Albert Howard)

Lady Eve Balfour (Evelyn Barbara Balfour; 1899-1990), a British farmer and educator, and Sir Albert Howard (1873-1947), a British agriculturalist in India who developed the Indore composting process, were founding figures in the Anglo-Saxon organic agriculture movement, The Soil Association.

The central hypothesis of Lady Balfour was that there is a close relationship between soil fertility and human health and that a decline in soil humus and fertility results in a decline in human health (Balfour, 1943). Similarly, Howard wrote that perfectly healthy soils are the basis for health on earth "*The undernourishment of the soil is at the root of all*" and health is a "*birthright of life*" (Howard, 1947 p. 12). Howard regarded soil humus as the most significant of all nature's reserves and the most fundamental component of a life-giving principle (Howard, 1940; 1947). The essential aim of the movement was to increase and maintain organic matter contents in soils, which was regarded as a guarantee of soil health: "*Nature's farming is the care devoted to the manufacture of humus. The great law of return … the great principle underlying nature's farming has been ignored'* (Howard, 1947 pp. 31-32). However, when we consider soil health and soil quality today, the perspective is wider in scope than soil organic matter content alone (Schjønning et al., 2002), as organic materials may include organic pollutants and micronutrients (e.g. Doran and Jones, 1996), metal contaminants (e.g. Kirchmann and Andersson, 2001; Schloter et al., 2003) and environmental risks derived from these pollutants (e.g. Swartjes, 1999).

Even though soil organic matter plays a central role in soil fertility, quantitative soil protection (erosion control) and the sustainability of cropping systems, crop growth and crop quality are also affected by other factors such as non-organically bound macro- and micronutrients, acid-base conditions, natural or man-made subsoil compaction, high native contents of non-essential elements etc. that can have a highly significant impact. An improvement in soil organic matter content alone cannot necessarily compensate completely for the impact of these factors on crop production. Thinking solely of the humus status for soil health and disregarding other major crop production factors is not in line with our current understanding.

Howard (1940) regarded the nutrient supply of plants through soluble fertilisers as a fatal error "*Artificial fertilisers were born out of the abuse of Liebig's discoveries of the chemical properties of soil. The effects of the physical properties of the soil were by-passed: its physiological life ignored, even denied, the latter a most fatal error. The essential co-partnership between the soil and the life of the creatures, which inhabit it, to which Darwin´s genius had early drawn attention, is wholly forgotten*" (Howard, 1947, pp. 71-72). Howard stated that there is "*a second method by which plants feed themselves. It is a direct connection, a kind of living bridge, between life in soil and the living* *portion* (plants) *of the soil*" (ibid. p. 22). Howard believed that only plant nutrients made available through this *second method* can feed plants properly (ibid. pp. 22-29). Although phosphorus and other nutrients can be supplied to crops through mycorrhizae, see Chapter 10 of this book (Ryan and Tibbett, 2008), there is no scientific evidence for a second pathway in general. Agricultural crops can only take up dissolved ions (Mengel and Kirby, 2004), dissolved chelated metal ions (e.g. Ullah and Gerzabek, 1991; Chen et al., 2001) or dissolved amino acids (e.g. Jones and Darrah, 1994; Näsholm et al., 2000) from the soil solution through roots and root hairs.

Balfour (1943) wrote in her preface that "*the physiological and spiritual well-being of man has its roots in soil*". She also used the term "*you are what you eat*", referring to the relationship between dietary composition and human physiology. However, organic matter content in soil does not seem to be the primary link between soil health and human health, but rather the shortage of macro- and micronutrients in soil not mainly stored in organic matter leading to hidden hunger (e.g. Welch and Graham, 1999; Rengel et al., 1999; Sanchez and Swaminathan, 2005). Furthermore, Balfour's view about soil health and spiritual health goes beyond approved knowledge.

Balfour made various statements on soil humus, some of which require comment and correction. She argued that large yields caused by inorganic fertilisers reduce the amount of humus in soil. According to our knowledge from soil biology and systems analysis, the opposite is true. Firstly, higher yields result in larger amounts of crop residues, both roots and above-ground plant parts. Thus, higher yields provide more crop residues, and thus more raw materials are available for humus formation. Secondly, roots cannot take up soil organic matter as such, although dissolved organic matter can promote the uptake of cations as chelates (e.g. Ullah and Gerzabek, 1991; Bocanegra et al., 2006). Carbon is taken up by plants as atmospheric carbon dioxide through photosynthesis. Thus, plants do not 'eat up' humus. Thirdly, the rate of humus decay is driven by a variety of environmental factors, especially moisture and to a lesser extent temperature (Davidson and Janssens, 2006). High yielding crops require more water and thus reduce soil moisture content more than low yielding crops (e.g. Andrén et al., 1990). Lowering soil moisture content reduces the rate of humus decomposition. So, contrary to Balfour's statement, numerous studies have shown that soil organic matter is increased through increasing yields (e.g. Balesdent, 1988; Andrén and Kätterer, 2001).

Another central view in the Balfour-Howard school is that artificial fertilisers speed up the rate at which soil organic matter is exhausted (Balfour, 1943 p. 53). As humus was considered to be the "*most significant of all nature´s reserves*" *(*Howard, 1947 p. 26), loss of humus means a decrease in soil fertility and must absolutely be avoided. Consequently, inorganic fertilisers need to be banned. But how true is this reasoning? Results from a great number of isotope studies have revealed that ^{15}N-labelled fertilisers are incorporated into soil organic matter through microbial turnover and that decomposition of soil organic matter is not accelerated through addition of inorganic N (e.g. Jansson, 1958; Jansson and Persson, 1982; Bjarnason, 1987). On the contrary, a depressive effect of inorganic N fertiliser on decomposition of soil organic matter and organic materials has been observed (Söderström et al., 1983; Puig-Gimenez and Chase, 1984; Green et al., 1995; Nyamangara et al., 1999). Furthermore, long-term field experiments with inorganic fertilisers have shown that soil organic matter content is maintained through regular applications of soluble nutrients. A possible initial decrease can be traced back to previously high applications of animal manures or organic-matter build-up when the soil was under grass (e.g. Johnston et al., 1989; Kirchmann et al., 1994; Gerzabek et al., 2001). This is in accordance with the studies cited in the paragraph above. Furthermore, ions present in soil solution through dissolution of minerals, exchange reactions with particle surfaces, mineralisation of soil organic matter etc. can be at similar concentrations as after fertiliser application. The view of Balfour and Howard on humus decomposition is not based on scientific evidence but on a misunderstanding of how inorganic fertilisers react in soil.

A further assumption in the Balfour-Howard school is that only composted organic materials should be applied to soil to maintain soil fertility. Balfour argued that addition of straw or green manure to soil has unreservedly damaging consequences on the crop. Although it is possible to increase soil fertility through large additions of compost (e.g. Johnston et al., 1989), it is equally possible to use other non-composted organic materials such as green-manure crops, anaerobically digested sewage sludge, straw in combination with nitrogen or peat to increase soil organic matter content (Kirchmann et al., 1994; 2004). The treatment of the residues, whether they are directly returned as fresh residues to soil or removed and returned as manure, compost etc. may affect the amount of soil organic matter formed (Kirchmann and Bernal, 1997), but it is primarily the amount of residues accessible for humus formation that controls the organic matter content in soil. The statement that all organic materials need to be composted has no scientific support. Furthermore, composting is followed by high losses of carbon in the form of carbon dioxide (e.g. Sommer and Dahl, 1999; Paillat et al., 2005) and nitrogen in the form of ammonia gas (Kirchmann, 1985; Eklind and Kirchmann, 2000; Beck-Friis et al., 2003), respectively, which is a disadvantage as C and N are not conserved in the material.

Balfour and Howard were inspired by the idea that recirculation of organic wastes produced in society back to soil could enable a permanent maintenance of soil fertility and they referred to early Asian societies described by King (1911). King had documented how early Asian cultures recycled source-separated toilet wastes, food wastes, ashes, sediments from ditches and other natural resources to agricultural land after partial composting. This documentation is often taken as an example and proof of the hypothesis that the complete recirculation of nutrients in society enables a sustainable agricultural production. However, the striking point in King's documentation is that the return of large amounts of organic matter to soil in these societies (many without composting) demanded enormous human effort and organisation. Due to an unevenly distributed availability of organic wastes in society, high water contents and thus expensive transportation, the recirculation of organic wastes to arable land is labour-intensive and costly if one wants to achieve an equitable redistribution (Kirchmann et al., 2005). Maximum recirculation of the plant nutrients found in wastes is definitely a very important goal, which might be achievable through extraction of nutrients from organic materials and their return as concentrated inorganic fertilisers (Kirchmann et al., 2005) or in a recycling system based on a very small spatial scale, e.g. within a village or on farm level itself.

Lady Balfour (1943) strongly argued and stressed the importance of food quality for human health. However, she disregarded the principal difference between changes in the diet and choice of organically grown food as the root cause for her observations on human health. In other words, she did not distinguish between changes in diet and quality of organically grown products as the reason for improved health conditions. This is remarkable since she pointed out the important role of whole food for health, i.e., consumption of non-refined flour (whole-wheat etc.), vegetables and fruits. She actually used this type of diet but never considered this in her conclusions. Her focus was on organically grown food only. It is therefore not possible from her studies to draw conclusions on the main reason for the health improvements reported. One may add that the indistinct mixture of dietary composition and food quality is still a common phenomenon when discussing food and health. Comparative analyses show that there are few consistent differences between organically and conventionally produced food (e.g. Ames et al., 1990; Basker, 1992; Woese et al., 1997; Bourn and Prescott, 2002; Ryan et al., 2004). Thus, there is no imperative logic to conclude that organic food products *per se* improve human health. On the other hand, there is massive evidence that the composition of the diet, i.e. the proportion of fruits, vegetables, saturated fats, refined sugar, fish and so on, is of great importance for human health (e.g. Willet, 1994; Ames, 1998; Trichopoulou and Critselis, 2004), which is also reflected in the dietary recommendations from government organisations.

3.3. Biological Organic Agriculture (Hans-Peter Rusch)

This type of organic agriculture was founded by the German physician and microbiologist Dr Hans-Peter Rusch (1906-1977) in collaboration with the Swiss biologists Dr Hans and Maria Müller. In his search for ecologically sensible forms of agriculture, Rusch observed nature and applied nature's principles in agriculture. He defined this as analogical, biological thinking, which was also the subtitle of his book (Rusch, 1978).

Rusch wrote that life is a unity whereby every part is of equal value and given equal rights, simple organisms to the same extent as humans "*Das Lebendige ist eine Einheit. Jedes Glied dieser Einheit ist gleichwertig und gleichberechtigt, ob es sich um eine Amöbe oder einen Menschen handelt*" (Rusch, 1978 p. 34). He further wrote that in nature there is nothing for its own purpose; it is only the purpose of wholeness "*In der Natur ist kein Ding um seiner selbst willen, es ist nur um des Ganzen willen*" (ibid. p. 15). Each organism is through the task of symbiosis indivisibly connected into a unit "*Die Gemeinschaft alles Lebenden …. ist durch die Pflicht der Symbiose unlösbar zu einer Ganzheit vereinigt*" (ibid. p. 15). He combined these two views of nature; firstly that all life on earth has the same inherent value (coequality) and secondly that the living is only correctly viewed in terms of interacting organisms (holism).

In fact, the same perspective on nature constitutes the basis for eco-philosophy (Fox, 1994; Drengson, 1997) introduced by the Norwegian philosopher Arne Naess (Naess, 1989) and earlier used as an explanation for the evolutionary history of humans by the German nature philosopher Ernst Haeckel (Haeckel, 1900).

Rusch criticised natural sciences. He stressed that the outlook for the wholeness of life has been lost due to reductive and highly specialised science "*Es gibt noch keine Naturwissenschaft, die den Aufgaben der Ganzheitsforschung gewachsen wäre*" (Rusch, 1978 p. 15). Rusch proposed a holistic view of nature incorporating both wanted and unwanted properties and believed that the control of unwanted organisms to help a weakened organism is meaningless in the long-term. The chemical fight against diseases and pests is not only hazardous, it is also primitive and stupid "*Wir müssen der Natur dankbar sein, dass sie uns mit Schädlingen und Krankheitserregern ein zuverlässiges Kriterium für fehlende Gesundheiten bereithält .... und biologische Unter- und Minderwertigkeit sofort mit Sicherheit ablesen lässt*" (ibid. p. 66); "*Der Giftkampf gegen Krankheiten und Schädlinge ist nicht nur gefährlich, er ist primitiv und dumm*" (ibid. p. 25).

Rusch (1978) shared the preference for humus with Balfour and Howard, also looking at soil fertility as the basis of all life. However, Rusch modified the focus of Balfour and Howard by emphasising that the process of humus formation is a sign of fertility and not that the material as such is most important. He believed that humification is in fact the greatest biological regulation known to nature "*Humifizierung ist ein Regulativ, sie ist in der Tat das grösste biologische Regulativ, das die Natur kennt*" (ibid. p. 88); humus is a manifestation of the biological achievement "*Humus ist Ausdruck der biologischen Leistung*" (ibid. p. 91).

Rusch observed litter decomposition, soil layering and humus accumulation in natural ecosystems and he transformed his observations into practical agricultural measures. According to him, normal humus formation is only achieved if one does not disturb the natural soil layering. Any soil tillage should be kept at a minimum to avoid disorder, one only needs to mimic nature "*Es ist also grundsätzlich geboten, jede irgendwie entbehrliche Bodenbearbeitung zu vermeiden…man muss die Natur nur getreu nachahmen*" (ibid. p. 80 and p. 215). His underlying reasoning was to let nature take its course. However, Rusch's statements cannot be corroborated from results of long-term field experiments in which soil disturbance and no-tillage are compared. Although layering typical of undisturbed ecosystems occurs in non-ploughed topsoils with highest organic matter concentrations at the soil surface, the total amount of soil organic matter is not enhanced in untilled soils in all cases (e.g. Antil et al., 2005; Alvarez, 2005).

According to the view that nature shows us how to treat it, Rusch pointed out that organic manures and composts are not suitable for the root zone and must only be used as surface cover

“*Organische Dünger und Komposte sind nicht wurzeltauglich und dürfen nur als Bedeckung benutzt werden*” (ibid. p. 158). Nature does not compost “*Die Natur kompostiert nicht*” (ibid. p. 166). However, Rusch’s view is only valid if nutrient-poor and energy-rich materials (e.g. Jansson, 1958; Kirchmann, 1990) are applied to the root zone and microbes and plant roots compete for nutrients during decomposition of these materials.

Rusch condemned artificial fertilisers as making it impossible to mimic the natural dynamic of nutrient release from soil to plant. He regarded this as the unavoidable mistake of synthetic fertilisers “*Es ist vollkommen unmöglich, die natürliche Dosierung der Mineralbewegungen zwischen Boden und Pflanze nachzuahmen, und das ist der unvermeidliche Fehler der künstlichen Düngung*” (ibid. p. 73). This argument against the use of synthetic fertilisers is probably the most sophisticated one proposed by the organic movement. They claim that the application of soluble salts to soil does not fulfil the demands of crops and, the most important point, that the supply is not synchronised with the growth of crops.

Although the argument by Rusch may sound reasonable, it is not in accordance with current scientific findings. Even if the supply of nutrients by the soil and their uptake by the plant are in synchrony in natural ecosystems due to the presence of living roots throughout the year, this is not the case in soils of arable systems. In ploughed soils, nutrients released from soil organic matter or organic manures can be lower in spring/summer when crop demand is highest and higher in autumn when there is little demand or no crops are present due to moisture and temperature conditions (e.g. Dahlin et al., 2005). The lower nutrient use efficiency of organic manures than of inorganic fertilisers both in the short- and long-term (Torstensson et al., 2006; Kirchmann et al., 2007) combined with higher leaching losses from organic manures (Bergström and Kirchmann, 1999; 2004) clearly shows the low level of synchronisation between nutrient supply and crop demand of organically bound nutrients.

It needs to be pointed out that adding salts to soil (fertiliser application) is in no way unnatural. Precipitation of soluble salts and ions derived from marine aerosols, nitrate from thunderstorms can add considerable amounts of nutrients to soil in a similar way as fertilisers. Furthermore, additions of animal urine or slurries, even in organic agriculture, means a supply of soluble salts of the same order of magnitude as fertiliser application, see Chapter 5 of this book (Kirchmann et al., 2008b). From a scientific point of view, soluble salts added either through urine or synthetic fertilisers are identical when present in the soil solution, although the origins of the ions are different. To put it simply, whether salts were produced by animal kidneys or by a specific technical process cannot be claimed as being a fundamental difference for the crop. Finally, healthy crops can be grown in pure nutrient solutions without any soil (e.g. Ingestad and Ågren, 1995).

Rusch argued that losses of nutrients are inevitable and high from artificial fertilisers compared with organic manures and that these losses occur because the organic but not the artificial fertiliser is adapted to the turnover in soil “*Ein wertvoller, teurer organischer Dünger kann immer noch billiger sein als der billigste Kunstdünger. Verluste durch Auswaschen und Festlegung der Mineralstoffe müssen in jedem Falle bei einer Kunstdüngung in Kauf genommen werden. Verluste treten dadurch ein, dass nur ein natürlicher, aber nicht ein künstlicher Substanzkreislauf an die wechselnden Lebensbedingungen ….angepasst ist*” (Rusch , 1978 p. 76). The argument that artificial fertilisers are lost to a larger extent than organic manures needs to be viewed from the other perspective. Leaching losses of N from organic manures are often higher than from inorganic fertilisers (Bergström & Kirchmann, 1999; 2004). Furthermore, leaching losses of N from organic agriculture systems can be significantly larger than those from modern farming systems (Torstensson et al., 2006). The lack of synchrony between nutrient release from organic manures and crop demand is the actual reason for higher losses from organic manures, as pointed out above. Independent of their origin, nutrients go through the same chemical and biological reactions in soil. The turnover of inorganic N fertilisers in soil and their naturalness have been explicitly explained by Jansson (1971).

3.4. Modern organic agriculture (IFOAM)

In 1972, the International Federation of Organic Agricultural Movements (IFOAM) was founded to represent the common interests of the different schools of organic agriculture but still allow their specific practices. This resulted in a new image of organic agriculture with less emphasis on methods but with a greater focus on aims. Today, the views and ideas of the founders of organic agriculture are regarded as history. It is believed that modern organic agriculture has progressed and bypassed the old schools. But is this so?

The common principle of the founders was to exclude synthetic compounds, such as water-soluble synthetic fertilisers, and use natural means and methods only. In fact, this principle is still a central prerequisite in modern organic agriculture and has not been questioned. It is still the incentive for choice of crops and rotations and weed, pest and insect control. Furthermore, biodynamic farming even now requires the use of compounds according to Steiner's instructions.

A number of additional arguments for not using synthetic fertilisers have developed over the last few decades. For example, inorganic N fertilisers are claimed to cause higher loadings to the environment than organic manures, and their production also requires relatively large amounts of energy. However, recent research has shown that inorganic N fertilisers in fact commonly cause lower N leaching losses than organic manures applied in equal amounts, which is discussed in Chapter 7 of this book (Bergström et al., 2008). The energy argument mentioned above also has to be evaluated in detail. Even though the energy consumption in production of N fertilisers is relatively high, the return in the form of energy build-up in crops is considerably higher, as discussed in Chapter 9 of this book (Bertilsson et al., 2008). In other words, the more recent arguments put forward are also questionable.

IFOAM does not mention the concepts of the founders but accentuates four general principles – health, ecology, fairness and care – as key goals for modern organic agriculture (IFOAM, 2006). Indeed, these principles are excellent and to make them become reality, appropriate methods and tools are required. Below, we analyse and comment on the four IFOAM principles and discuss whether organic agriculture is a suitable way to achieve them.

3.4.1. Principle 1 - Health

"*To sustain and enhance the health of soil, plant, animal, humans and planet as one and indivisible*" (IFOAM, 2006).

According to this, there is a health chain from soils that produce healthy crops, fostering health of animals and humans etc. Originally, this way of thinking was typical for Balfour (1943) and Howard (1940), saying that a *living soil* in particular is a necessary condition for healthy plant growth and for humans. However, soil health (A) does not necessarily provide a guarantee of crop health (B) or animal or human health (C, D) and planet health (E). There is simply no imperative logic that A leads to B and finally to E, although we would like to believe so. Even if crops greatly benefit from fertile and healthy soil, soil conditions are not the only determining factor for crop health. Other factors can be of greater importance, such as weather and climate, plant protection against non-soil borne diseases through NPK fertilisers (Reuveni and Reuveni, 1998), damage through animals and pests, formation of natural toxins in crops etc. Similarly, healthy crops do not automatically guarantee good health of the consuming organisms. For instance, the micronutrient requirements of animals or humans can be much larger than the requirements and uptake by crops (McDowell, 2003). In simple terms, the nutritional composition of a healthy crop may not be adapted to the consuming organism. The 'chain' conclusions that perfect conditions in soil finally lead to a healthy planet are highly questionable.

3.4.2. Principle 2 - Ecology

"*To base organic farming on living ecological systems and cycles, work with them, emulate them and help sustain them*" (IFOAM, 2006).

In the full IFOAM text it is explained that "*production is based on ecological processes and recycling. Organic farming should fit the cycles and ecological balance in nature*". In other words, ecological systems and cycles should serve as a prototype for organic agriculture. This view is similar to that proposed by Rusch, who wanted to practise agricultural methods following processes observed in nature. However, both organic and conventional agricultural systems are man-made and not naturally occurring. In fact, the cultivation of natural ecosystems such as forests, wetlands, grassland etc. into agricultural land is a drastic conversion. Agriculture means that crops are sown and harvested, weeds are controlled, soils are tilled, and animal manures are collected and applied. Furthermore, the same ecological processes and cycles exist and take place in organic and conventional agricultural systems.

Ecological processes and cycles are proposed to serve as a model providing guidelines for how to treat nature. However, the purpose of agriculture is not to emulate ecological processes but to use and take care of nature for the purpose of food production. Ecological processes simply follow or react to any prevailing conditions, independent of the cause. For example, application of manure to soil increases microbial activity and nitrogen processes in soil to levels much higher than those occurring in undisturbed nature. Our task is to protect the soil from erosion and pollution, to maintain its fertility by application of necessary nutrients, and to manage agro-ecosystems so that nutrient losses are minimised. If we do that, soil processes will continue to work according to these conditions.

Many unnatural measures can be found within organic agriculture. Various industrial wastes (e.g. slag, vinasse, meat and bone meal from abattoir offal) that are not naturally occurring are applied to soil. On the other hand, recycling of toilet wastes to organically managed soils is not allowed, see Chapter 5 of this book (Kirchmann et al., 2008b). Man-made crop varieties and not wild types are grown. Machinery is powered by fossil fuels and animal or man power is very seldom used.

3.4.3. Principle 3 - Fairness

"*Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities*" (IFOAM, 2006).

The principle of fairness adds new aims to organic agriculture, not explicitly addressed by the pioneers, such as respect, justice, eradication of poverty, animal welfare, equitable systems for distribution and trade, as well as social costs. The emphasis on these aspects is, without doubt, commendable and definitely wanted within society. Still, the question is whether organic agriculture is the best way to achieve these aims.

Furthermore, supply and quality of food is addressed "*Organic farming should contribute to a sufficient supply of good quality food and other products*". Again, sufficient supply of high quality food and other products is a general aim for all agriculture. However, organic agriculture produces much less food per area than conventional agriculture and thus requires more land to be used for cropping, see Chapter 3 of this book (Kirchmann et al., 2008a). Organic products can also be affected by pests, which lower the quality. On the other hand, growth of the human population presupposes that much more food has to be produced in the future. Lal (2006) estimated that it is necessary to increase world-wide average cereal yields from 2.64 Mg ha^{-1} (in the year 2000) to at least 4.30 Mg ha^{-1} (by 2050).

Another topic addressed is animal welfare –"*animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being*". We are convinced that humans are obliged to show kindness and respect to livestock, as well as being morally responsible for their health and well-being. However, '*natural behaviour*' is not always wanted. Humans have kept livestock for many years, resulting in a selection of animals with behaviours that differ from the wild species. Natural behaviour cannot be the only guideline for livestock management because even domesticated animals can do harm by victimisation, fighting and cannibalism. It is important to keep animals in such a way that the special requirements of each species are fulfilled and that destructive forms of behaviour can be prevented.

3.4.4. Principle 4 - Care

"*Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment*".

Caring for the environment is a basic principle necessary for its sustainability in order to provide humans with wellbeing, food and other essentials. In most societies, there is consensus to care for the environment and the responsibility of humans towards nature is clear – to respect, to utilise and to care.

It is the explanation of how to care for the environment that is remarkable in the IFOAM document, which states that "*Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time*". The problem with this explanation is that any kind of tradition including occult practices etc. are regarded as being of similar value to scientific results. For example, use of biodynamic compounds is explicitly accepted as a valid solution.

To make it very clear, our criticism is not based on a negative attitude towards accumulated wisdom or traditional and indigenous knowledge as such - knowledge gained this way can be very valuable - but on the fact that this knowledge can be both useful and of disadvantage for the sustainability of agro-ecosystems. It may also be a barrier to other well-founded practices.

4. ETHICS IN ORGANIC AGRICULTURE

The previous analysis shows that organic practices are originally based on certain philosophical views on nature (summarised in Table 2) and that there is a lack of agreement between these practices and the scientific evidence. In this section, we comment on this conflict. As indicated earlier, founders and followers of organic agriculture prefer a holistic rather than a reductive view, organic rather than mechanistic studies and in some cases intuition/feeling rather than logical reasoning. Behind these positions one can trace valuations of nature, which we regard to be the roots of organic agriculture. In the following we characterise these valuations and discuss shortcomings.

4.1. Idealisation of nature and cooperation with nature

The literature on organic agriculture describes and positions nature as being ideal and the functioning of nature is the prototype to be emulated. Letting nature renew and restore itself and using and adapting to natural cycles is seen as a model. Processes and functions occurring in nature are regarded as being superlative and naturalness is seen as a prerequisite for sound food production (Verhoog et al., 2003). Ecological wisdom, yet not well-defined, is assumed as the guiding authority guaranteeing sustainability. Technical innovations are generally deemed inferior to natural means and methods. Nature is simply assumed to know best and occasionally is even referred to as being 'good' (Vilkka, 1997). The idealisation of nature is one of the fundamental principles from which organic practices can be deduced.

Another underlying principle of organic agriculture is to cooperate with nature rather than to dominate and control. Nature is seen as a partner, where all organisms contribute to the health of

Table 2. Summary of characteristics of the schools of organic agriculture

Founders and organisation	Philosophy and view on nature	Reasons for exclusion of synthetic fertilisers and pesticides
R Steiner (1861-1925); Biological dynamic farming	Anthroposophy; 'Forces' in nature provide salvation	Artificial materials disturb the 'flow of forces' in nature and destroy the 'spiritual quality' of crops
A Howard (1873-1947); E Balfour (1899-1990); Soil Association	Nature romanticism; Undisturbed nature embodies harmony. Humus guarantees soil fertility providing health. Health is a birthright	Humus is the most significant of all nature's reserves. Inorganic fertilisers speed up humus decay
H-P Rusch (1906-1977); Biological organic farming	Eco-philosophy; Nature is a perfect unit with parity between all forms of life	Inorganic fertilisers are not adapted to the demand of crops. Diseases and pests are natural destruction processes
International Federation of Organic Agriculture Movements (since 1972); (IFOAM)	Environmentalism; Nature is the master	Organic practices are superior and therefore self-evident

the whole. In this relationship, all forms of life are often classed as equal in terms of their intrinsic value. For example, the life of a plant is classed as being as valuable as the life of a human being. By stressing parity among all living organisms (biocentrism), the importance and interdependence of life are given much greater emphasis. Humans can perceive themselves as part of nature and not as a separate entity apart from nature. In other words, through rejection of an anthropocentric view, man and nature can re-establish unity. Applying these ethics, humans can build fair relationships with other organisms and take action to counteract abuses of nature.

In fact, the fundamental view of nature as being ideal and complete motivates many academics to argue for organic practices and may also direct consumer choices in preferring organic food. The crucial question arising is whether the two fundamental views outlined above are a reasonable and sound basis. What type of system is nature? How should humans view themselves in relation to nature? What ethical principles would be in accordance with our experience of nature? Sound ethical principles influence our thinking, decisions and actions in our relationship with nature and thus require special attention.

4.2. The dualistic character of nature

We are concerned that the idealisation of nature does not deal with the harsh side of nature in a satisfactory way and is thus not considering nature as a whole. It represents a one-sided view, that nature is fantastic, magnificent, beautiful, admirable, etc. with a proper fit and functioning of species, and particular orders and interrelation of ecosystems that seem to function well without human intervention. All this may lead to the conclusion that nature is perfect. However, natural disasters (e.g. hurricanes, earthquakes and tsunamis) illustrate a self-destructive and non-predictable side of nature. Long-lasting ice ages, land loss, continental movements and meteorite collisions further exemplify desolation and species extinction by natural causes. Actually none of these destructive forces is mainly the result of human activity, but they can all destroy the majority of organisms, including humans. In other words, natural disasters can greatly exceed the environmental damage caused by humans.

Furthermore, nature is dangerous and not at peaceful harmony. Wild animals suffer from predator attacks, malnutrition, parasites, diseases etc., showing the lack of 'goodness' in nature. In fact, the natural behaviour of animals has no morality and demonstrates what in human terms would be called cruelty, e.g. the strong bullying the weak and the survival of the fittest. In domestic livestock, traits are continuously being selected that are different from those found in the wild. Over the course of civilisation, humans have devoted great effort to developing means and methods to eliminate the dangers and unwanted properties of nature in order to minimise negative impacts on plants, animals and humans.

It can be concluded that nature from a human perspective has a dualistic character with opposing qualities: beauty and order through its life processes on the one hand and chaos, cruelty and desolation on the other. When this dualistic character of nature is ignored and excused, it is difficult to deal with nature in a competent and efficient way. For example, in an idealised view, the common occurrence of diseases and suffering in nature is either denied or seen as nature's way of regulating itself. However, the suffering found in nature is unacceptable as a model for humans. On the contrary, one of the founders of organic agriculture claimed that perfect health is a birthright (see Table 2), but there is absolutely no evidence that disease and suffering would be absent if humans were to revert to nature.

4.3. Human stewardship

Equally important to recognition of the dualistic qualities of nature is understanding of the human relationship to nature. Humans living on planet Earth are dependent on nature for survival and must take care to sustain nature in its wholeness. In fact, how humans position themselves towards other organisms determines how nature is viewed and treated (Table 3). Should humans act as cooperating partners or managers of nature?

According to the modern school of organic agriculture, a cooperative relationship between humans and nature is proposed as a fundamental principle. This mainly refers to a biocentric relationship, which means that human life is not classified higher than life of other organisms, although this is not always clearly mentioned. However, this is an untenable position. Humans have the ability to recognise all other organisms and can at least partly comprehend planet Earth. Furthermore, human knowledge enables us to improve poor natural conditions, for example supplying nutrients where natural deficiency is limiting growth. We can work out means and programmes to save species from eradication etc., but we also have a totally unique ability to destroy everything that grows, crawls or runs. All these abilities automatically place humans in a position of leadership on Earth.

Ethics based on cooperation or biocentrism aim to prohibit humans from playing a dominant role in order to establish biological synergy and harmony between humans and nature. According to the motto 'let nature do the job it knows best', the less nature is affected by man-made innovations,

Table 3. Ethical positions determine human attitudes towards nature

Ethical fundament	Perception of nature	Relation to nature
Theocentric		
Humans believe that God exists to whom they are accountable for	Nature is included in the Fall of Man affected by sin - not perfect	Use for benefit and joy entrusting man stewardship
Anthropocentric		
Humans are above nature and believe in no higher authority to be accountable for	Nature is dualistic characterized by both wanted and unwanted properties	Use for benefit and joy including stewardship and responsibility
Biocentric		
Humans are in parity with all living and believe in unity	Nature is an ideal system comprising of a perfect wholeness	Humans need to learn from nature how to imitate it

the better. The biocentric position sets boundaries to human creativity and limits human activity to the exclusive use of naturally occurring compounds. As a consequence, development of artificial products through science is principally rejected, which is also in line with organic practices. The possibility of humans accomplishing new feats is all but eliminated.

Taking philosophies to logical endpoints can reveal their weaknesses. According to the ethical valuation that all forms of life, including viruses and bacteria, are of equal intrinsic value, disease-causing organisms would not be combated. This means that ethics based on cooperation with nature or biocentrism neglect the issue of human survival through the commitment to conserve the biotic community in total. It is obvious that this position is not pro-human and will ultimately be destructive for human societies. We are convinced that both human needs and environmental stewardship need to be considered in the search for sustainable forms of management, but with a pro-human perspective. Humans must show more respect for human than other forms of life.

As the dualistic character of nature involves desirable and undesirable properties, the difficulty is not only in conserving nature, but also in finding solutions that minimise the negative effects of nature on humans. Humans are the only organisms on Earth that have the capacity, overview and knowledge to use, control and care for nature. Humans have created food production systems that have improved our standard of living and will create new food systems in the future. On the other hand, humans can completely destroy ecosystems and eradicate species and therefore they have the obligation to take full responsibility for ensuring that nature can be preserved and new ecosystems created, e.g. urban or agro-ecosystems. Although human domination can be used for best management or can be misused, avoiding taking a leadership role is not a viable option. The supremacy over other organisms calls humans to be stewards on Earth with a moral commitment firstly towards humans but also towards the environment.

5. CONCLUSIONS

The European founders of organic agriculture were concerned about deterioration in product quality and a decrease in soil fertility. Their common view was that if industrial applications became a model for agricultural progress and development, this would lead to serious negative consequences for nature and mankind. They were convinced that use of natural means and methods in agriculture are intrinsically better than others. Their mission was to convince others to base food production on the exclusion of modern means of production and to show that industrialization of agriculture was the wrong direction.

All founders mistrusted and disliked science as a valuable tool to explore humans and nature, including agriculture. They condemned the reductive character of science as misleading or degraded science as being of limited value. Actually, none of the organic agriculture theories are based on scientific hypotheses or scientific evidence. Instead, strong views about nature and how to treat and deal with it, derived from philosophies about life are the origin of organic agriculture.

Biological Dynamic Agriculture grew out of Anthroposophy, the Soil Association is based on Nature Romanticism, Biological Organic Agriculture has its roots in Eco-philosophy, and modern organic agriculture is based on Environmentalism.

The analysis of the organic agriculture schools reveals that they are filled with flaws and errors. There is no consensus about agronomic practices among the founders, e.g. how to treat animal manures, how to use organic manures, how to till the soil, how to deal with pests etc. The concept of naturalness, excluding synthetic fertilisers and synthetic pesticides, is simply seen as a guarantee for the superiority of organic production. The analysis of modern organic agriculture reveals that the fundamental ideas of the founders are not explicitly mentioned anymore but are still alive. The four principles of modern organic agriculture uphold the way of thinking of the founders but also emphasising desirable aims common for all types of agriculture.

Two fundamental valuations of nature were identified to be roots of organic agriculture. One principle is to regard nature to be an ideal system comprising a perfect wholeness. Nature´s wisdom is seen to be the master, whereby natural processes and functions serve as a model and standard to be emulated. The other principle is to base human relationships towards nature on cooperation in order to achieve biological synergy and harmony. However, both principles are insuffient not taking into account the dualistic character of nature and human needs in a satisfactory way.

It is our responsibility as scientists to use the best knowledge and values available in the search for sustainable forms of agriculture. It remains to be further discussed whether organic agriculture methods can provide a sound contribution to future food production systems, as organic principles exclude other potentially superior solutions.

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