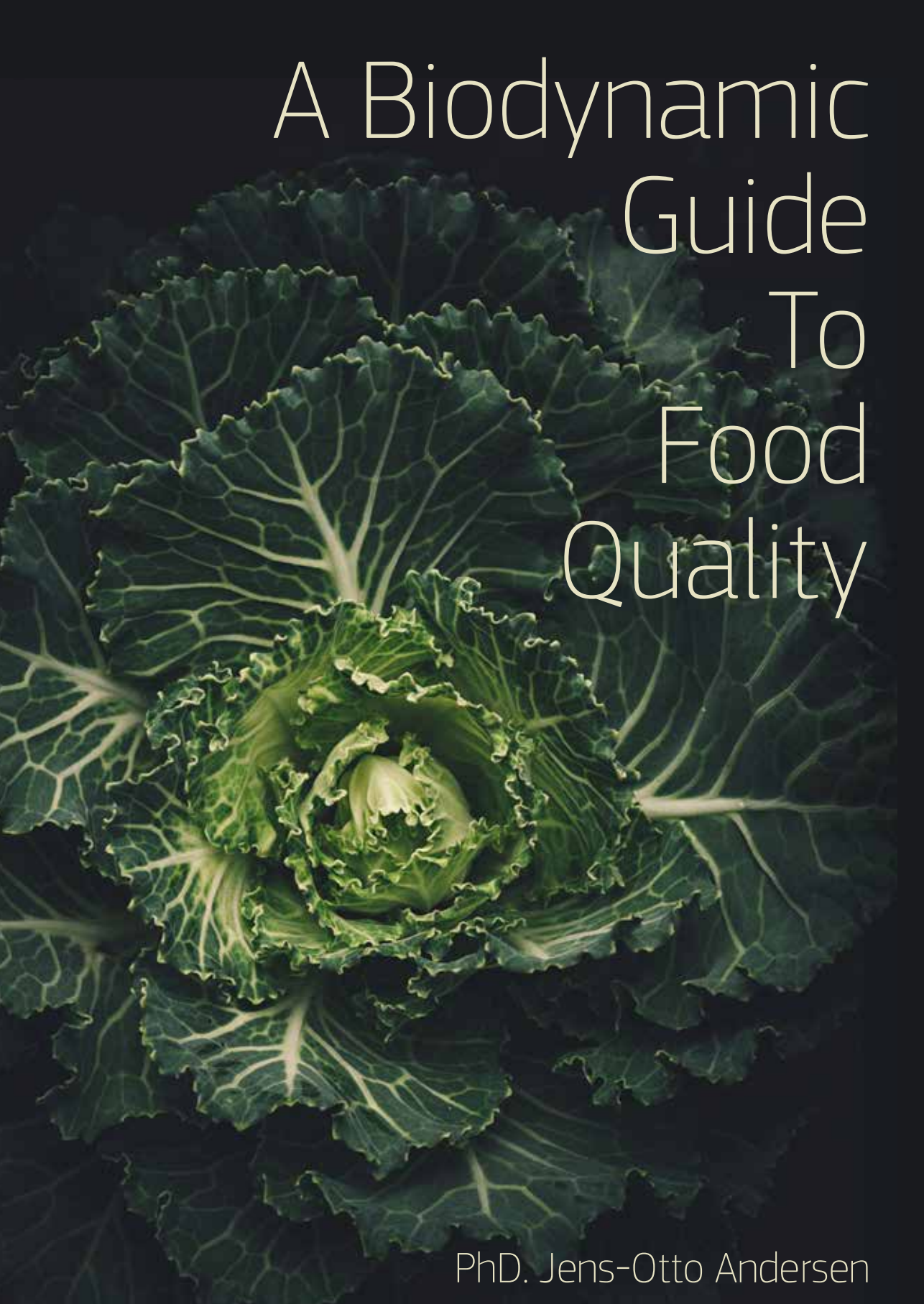
A Biodynamic Guide To Food Quality



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A Biodynamic Guide To Food Quality

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'The book can be ordered, and downloaded freely, at www.biodynamiskforskning.dk'

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Content

Jens-Otto Andersen worked on organic and biodynamic farms in Denmark and Norway during 1978-86. Worked part-time in the Danish Demeter organisation with certification of farms during 1993-2000. In 2001, as an agronomist, he took a PhD degree concerning the biocrystallisation method. Also, in 2001, he was co-author of a Danish research report on 'Organic foods and human health', and co-founder of the international research association Food Quality and Health (FQH; www.organicfqh.org). Since 2001, he has worked as research coordinator in Biodynamic Research Association DK. During 2001-2012, together with German and Dutch researchers, he worked with developing and validating the biocrystallisation method. During 2006-2012, together with Swiss and Dutch researchers, he documented that the biocrystallisation method can differentiate homeopathic D30 preparations. Author of the book 'Vitality – from soil to stomach' from 2019. Today, he works with developing methods for examining the vitality of agricultural and horticultural crops.

Foreword

Throughout my years as a biodynamic researcher, I have been confronted with questions from younger people. All over the biodynamic movement you can meet the new generations of younger people. Some are there for just a short visit, working on a farm during a summer, assisting for some months in a research project, or selling biodynamic foods in a shop. Others have started what will be a life-long engagement in some area of biodynamic agriculture.

Over the years, I have learned to highly appreciate the questions from these younger people. Repeatedly, I am surprised by their bright questions, aimed straight at the centre of the matter in question. Their questions, mostly posed in an effortless manner, trigger a growing awareness about the complexity of both the practical and spiritual aspects of biodynamic agriculture.

Nothing can fully replace a fruitful, personal dialogue. But it is my hope that this book can contribute to the never-ending dialogue taking place as an integral part of the development of biodynamic agriculture. A dialogue which is sparked not least by the bright questions from the younger generations.

Also, it is my hope that the value and limits of the present natural science will be noted, as well as the reality and potential of the spiritual science described.

Jens-Otto Andersen

November 2021, Biodynamic Research Association, Denmark


Agriculture for
10,000 years

1

In this chapter we will look at the different types of agriculture, from the numerous traditional ways of farming around the world to modern conventional agriculture. This latter production systems has gradually moved away from nature, from its local resources and ecosystems, from smaller farms towards large industrial production systems, as well as aquaponic production systems. The question arises if today's foods can keep us healthy. In addition, we will also look at the birth and present status of biodynamic agriculture as a nutritional impulse, and at spiritual science, which is the basis of this impulse.

Agriculture around the world

Agriculture based on cultivated crops and domesticated animals has been a fundamental human activity for more than 10,000 years. During the transition away from hunting and gathering whatever nature could offer, subsistence farming came about whereby small plots of land were cultivated for as long as the yields were acceptable, after which new plots were cleared and cultivated. Then, agriculture with more permanent settlements started to appear more than 8,000 years ago. Thus, an advanced agriculture appeared in old Mesopotamia, in present day Iraq, and later highly effective wheat production took place along the river Nile. Here, the pharaohs exported huge amounts of wheat to the armies of the Roman Empire.

Today, we find large-scale grain productions under different climatic conditions: on the American prairie lands, the Eurasian steppes, and the Pampas of Argentina. In the temperate grasslands, there is livestock ranching, with literally thousands of cattle and sheep, producing meat and mutton as well

as hides and wool for home and export markets. In the Mediterranean area, with dry summers and wet winters, are intensive farming systems with grains, fruits and vegetables, and wine grapes. When looking more towards the temperate North-Western Europe, to Ukraine, and parts of Russia, we find a range of mixed farms, based on a mixture of crop cultivation and animal husbandry. Here each farm has its individual characteristics, originating from the landscape, the natural resources, the regional and local market conditions, as well as the skills and interests of the farmer.

The conventional agriculture, which gained strong momentum in Central Europe after the Second World War, has since steadily moved away from farming within the context of a landscape and the natural ecosystems, with farm animals often spending their entire lifes in intensive indoor production systems. Biological diversity on conventional farms also decreased compared to nearby organic farms. Later, it was documented that a spectrum of pesticide residues could be found in ground water reservoirs serving as drinking water for larger cities, and that the routine use of antibiotics in animal production generated

multi-resistant bacteria. Today, these side effects represent a serious concern to public healthcare systems.

Aquaponic production systems

Many consumers are not aware that a growing number of conventionally grown vegetables and fruits are produced without soil. Instead, these crops are grown in aquaponic production systems. For decades, salads have been produced using such methods, but today cucumbers, tomatoes, cabbages, peppers, beans, peas, radishes, melons, and onions may also be grown this way. When we buy a conventionally grown cucumber in a large supermarket in one of the Central European countries, this will have been grown using aquaponics. Many consumers are not aware of this fact since companies are not legally bound to label this information yet.

In aquaponics, soil, rain, and sunlight have been replaced by industrial inputs. The soil is replaced by inactive growth media such as mineral wool boards, with water containing 16-20 water-soluble nutrients flowing around the roots. The sunlight is replaced by artificial light, and the atmospheric concentration of CO_2 is regulated to increase the plant growth. By accurately controlling the concentration of oxygen, carbon dioxide and nutrients, as well as temperature, humidity and light, the crops will grow more rapidly and give a larger yield than when grown in soil. [1]

The first development of aquaponic systems was driven by the need for vegetables and fruits in areas with extreme conditions. Thus, NASA, the US National Aeronautics and Space Administration, was among the first to experiment with aquaponics, in order to enable their astronauts to stay longer in space. In 2015, the first aquaponic salad was grown and harvested under weightless conditions on board the international space station ISS. Aquaponic systems have also been used for decades in the extreme polar conditions in Antarctica. A US research station runs throughout the year on Ross Island, with a staff of more than 200 people during the winter months of total darkness. Here, crops such as salad, spinach, tomatoes, cucumbers, peppers, and spices are grown. For the rest of the year, supplies are regularly flown in from New Zealand.

The ongoing development of aquaponic systems points towards large halls, with plants growing on long tables, stacked on top of each other. Not least,

researchers are focused on LED bulbs with different colours, with the expectation that specific combinations of light frequencies can be matched precisely to the different growing stages of the plants, thereby optimising the growth process. Employees are dressed in 'space suits' to avoid bringing undesired microorganisms into the closed system.

Since the costs of aquaponic production systems are lower than those of soil-based methods, they are rapidly expanding worldwide. Thus, authorities in Chinese provinces find that aquaponic systems are the most reliable way to feed their fast growing cities. Similarly, neighbouring Japan now has more than 200 large companies using aquaponics. Indeed, the Japanese import of foods is the world's largest, compared to domestic production.

Organic agriculture

Around the world, we find numerous traditional types of agriculture which may be termed 'organic', due to the absence of mineral fertilisers, pesticides, modern grain varieties, and antibiotics. Modern organic agriculture, as we know it in the present EU countries, gained momentum in the 1970s. Many farmers were concerned that the fertility of the soil as well as the health of animals and humans would be weakened using inorganic fertilisers. There was also concern about the natural ecosystems since many of the pesticides killed not only the harmful insects but also a broad spectrum of insects that are important for the biological balance in nature and agriculture.

The main characteristics of modern organic agriculture are that the farm is seen as an integrated part of the surrounding natural ecosystems, and that mineral fertilisers and pesticides are banned. Later, a broad range of regulations was developed, concerning the use of various organic fertilisers, animal fodder, plant breeding techniques, additives, processing techniques, cosmetics etc. The national organic farming movements can be members of IFOAM – the International Federation of Organic Agricultural Movements. This organisation, founded in 1972, with more than 800 members worldwide, has set up four basic principles upon which the diversity of regional and national movements should develop: (a) sustaining and enhancing the health of the soil, plant, animal, human and planet as one and indivisible; (b) working with and sustaining living ecological systems and cycles; (c) building on relationships that will ensure fairness with regard to the common environment and life opportunities;

(d) managing the production in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. [2]

The word ecology may be defined as 'knowledge of nature's household'. Thus, the organic farmer should work with and not against nature. The important

nitrogen for the crops should come from livestock manure, from crops such as clover grass which collect nitrogen at their roots, and from the gradual release of nitrogen from the soil as a result of the activity of the soil microorganisms. The farmer should prevent diseases in the crops not by using pesticides, but through the right choice of varieties and crop rotation - a systematic shift between different crops on each field. Harmful insects can be prevented, for example, by promoting the natural bird life in the local area.

The organic farmer cannot routinely treat his/her animals with antibiotics, as is mostly the case with large-scale conventional farmers. In addition, after a medical treatment of organic dairy cows, the milk must be retained for twice as many days as is the case in conventional farming. These cows are milked separately, and the milk cannot be sent to the dairy due to the possibility of antibiotic residues in the milk.

In 2019, Denmark was the first country to attain an organic market share of 10%. Many consumers still ask why the price difference between conventional and organic milk is rather small, whereas the difference for meat is relatively large. A major reason is that conventional farmers can more easily mechanise the production. They are more able to benefit from large-scale production systems, and they face fewer restrictions on their choice of fodder, including cheap foreign protein rich fodder. This means that conventionally reared animals will reach the desired slaughter weight faster. However, the sale of organic meat has increased over the past decade in most European countries. Today, an increasing number of consumers are willing to pay for the more expensive organic meat, due to the better taste and the better animal welfare.

Can today's foods keep us healthy?

Since the Second World War, plant breeders have greatly increased the yield of our agricultural crops, so that today a field of wheat will give two to three times more than what our grandfathers harvested. The breeders have also changed both the yield and taste of our vegetables. When we visit the Mediterranean countries, we notice at their fresh food markets an abundance of tomato varieties, small and large, round, and elongated, with red, yellow, and even black colours.

We soon realise that some of these have more taste than those at home. The fact is that early on the larger supermarket chains in Central Europe asked plant breeders for tomatoes with a thicker skin so that they would look fresh for longer and could be transported from the supermarket to the customers' fridges with less chance of damage. Furthermore, greenhouse gardeners asked the breeders for tomatoes that would all ripen at the same time on the tomato truss. After some years, the breeders developed new varieties that could fulfil the requirements of both the supermarkets and the gardeners. However, in the process the tomatoes had lost some of their taste. [3] Today, researchers are working with genetic techniques to re-design the taste of new tomato varieties.[4]

This effect of modern plant breeding is not limited to the tomato. The vegetables which our grandparents cultivated – carrot, cabbage, beetroot, etc – were stronger in taste, some even bitter. As a PhD student I followed a field trial with celery varieties, started by one of my collegues but never published. The trial included five celery varieties, two older and three modern varieties which were grown on three biodynamic and one organic farm. The hypothesis was that there were systematic differences in growth, yield, taste, and the ability to resist attacks from microorganisms yield. Indeed, the results showed a clear pattern: the yield was noticeably higher for the modern varieties, however the older varieties were better at resisting microbial attacks during the winter storage, so that more celeries were still saleable in the spring. Last but not least, a panel of gastronomical chefs were asked to score the degree of celery flavour in the five varieties. The following pages show that there may indeed be health-promoting properties connected to these flavours. [5]

'Vintage vegetables' and Type 2 diabetes

Let us look at a recent pharmaceutical project to illustrate this question. A group of Type 2 Diabetes patients were divided into three sub-groups according to their test diet:

*The '**control group**' who were told not to make any changes to their daily diet.*

*The '**vegetable group**' who were told to eat 500g of fresh vegetables (cabbage, beetroot, carrot, celery) daily from the supermarket.*

*The '**vintage vegetable group**' who were told to eat 500g of fresh vegetables (cabbage, beetroot, carrot, celery) from older varieties daily, with an increased content of bitter, so-called secondary compounds.*

These 'vintage vegetables' were grown specifically for this experiment, based on seeds from the NordGene Plant. This institution is responsible for preserving, storing, and maintaining older Nordic plant varieties. Today, it holds more than 33,000 seed samples. The bank also supplies seeds to plant breeders and research projects, as well as small amounts to private individuals.

The 'vintage vegetable' experiment ran for three months. After this, the participants' blood sugar levels and diabetes symptoms were evaluated by independent doctors. In the control group, with no changes in their diet, there were - as expected - no changes in their blood sugar level. On the other hand, the other two subgroups had improved their blood sugar levels. Most surprisingly, nearly 70% of the participants in the 'vintage vegetable' group had improved their blood sugar level to a degree that their clinical symptoms of Type 2 Diabetes had disappeared!

The 'vintage vegetables' had reduced their symptoms to such a degree where they no longer needed the medicine which some of them had been taking for years. [6]

The perspectives from this experiment are enormous, not only for reducing the large amount of finances, but indeed for increasing the public health.

The scientist in charge of the experiment attributed the surprising effect of the 'vintage vegetables' on the blood sugar level to their content of bitter compounds. He was not expecting that these vegetables would replace the patients' diabetes medication, but that a daily diet including 'vintage vegetables' would markedly reduce the need for medicine for many diabetic patients.

It should be added that the participants from the 'vintage vegetable' group found it hard to eat so many vegetables with bitter compounds. In any case, the experiment points to the fact that our common vegetables have lost some crucial health-promoting properties as a result of modern plant breeding. Clearly, we have paid a high price for vegetables with a milder taste.

The problems of the present nutritional labelling

Another important question concerns the microbial flora which all vegetables and fruits develop on their surface. We know that a healthy adult will have roughly 2 kg of microorganisms in his/her intestines, that this microbial flora has a major influence on our health, and that a continuous renewal of the microbial flora is an integral part of maintaining our health. At many hospitals around the world, patients who have had a part of their intestines removed due to cancer are offered injections of faeces, from a close relative, into their rectum as a way of speeding up the recovery of their digestion and health. A small amount of faeces contains an immense population of microorganisms which will re-colonise the intestines after the operation, and thereby restore the health of the patient more quickly. Here, the microorganisms we obtain daily from our vegetables and fruits contribute to the daily 'maintenance' and renewal of the intestinal microbial flora.

When we look at the present official approach to food quality, as reflected in the nutritional labelling on supermarket products, these labels in no way reflect the importance of secondary compounds. The term 'secondary compounds' covers several groups of compounds: alkaloids, phenolics, flavonoids, glycosides, tannins etc. These compounds do not concern the primary plant metabolism, cell growth and energy production. Instead they concern the plant secondary metabolism, including taste, smell, colour, defence towards insects etc. In addition, they are called secondary compounds as opposed to minerals, carbohydrates, proteins, and fats, which are traditionally termed primary nutritional compounds.

Thus, the nutritional labelling on supermarket foods contains no information concerning secondary compounds. According to the contemporary nutritional science, as humans we need in our diet roughly 12 vitamins, 20 minerals, some fibres, various carbohydrates as well as essential amino acids and fatty acids. However, this official labelling represents a gross simplification of the present scientific knowledge. We saw the effect of bitter compounds on our blood sugar regulation. And these bitter compounds represent only a fraction of the secondary compounds. Biochemists have identified more than 1,000 of these in coffee, over 2,000 in older strawberry varieties, and even more in spices and medical plants. Several of these are expected to positively influence our health.

Interestingly, many of these compounds are antioxidants, which are well-known for their beneficial role in our metabolism, not least through neutralising free radicals which generate harmful oxidation processes in our cells. Biochemists have routine techniques for analysing the total antioxidant activity of vegetables and fruits. Including this information would increase the relevance of the contemporary nutritional labelling.

We know that there has been a decline in specific secondary compounds in our foods due to plant breeding since the Second World War, and we may assume that vegetables and fruits from aquaponic productions contain fewer beneficial microorganisms, as compared to soil-grown vegetables and fruits. Finally, when we add to this the presence of several pesticide residues on conventional vegetables and fruits, we are indeed confronted with the question: Can today's foods keep us healthy?

To answer this question, we can take various approaches. The most well-known is through the chemical analysis of say minerals, carbohydrates, amino acids, fatty acids, vitamins, and secondary compounds. Here, we work on the compound level of the foods. We may also perform animal and human diet experiments, and afterwards examine the organ functions as well as the cognitive functions of the animals and humans. Here, we work on the whole organism level. Unfortunately, the latter experiments are time-consuming and expensive, and consequently they are only rarely used.

The birth and status of biodynamic agriculture

In the 1920s, a group of German farmers noticed a decrease in seed quality, soil fertility, and crop and animal health. Earlier on, an alfalfa crop could grow in the same field for 20 or even 30 years; however, at the beginning of the 1920s, in many places the crop now lasted less than 10 years. The protein content of wheat, as well as the health of potatoes had also gone down. Being inspired by the anthroposophical movement, they asked the German-Austrian philosopher and scientist, Rudolf Steiner, to present a basis for a future agriculture. In 1924, Steiner held a course including eight lectures, which today is called the Agriculture Course. This course represents the birth of biodynamic agriculture. [7]

During the course, Steiner pointed out the need to test the measures which he

had presented, and an 'experimental circle' was established. Before the start of the Second World War, the circle included approximately 800 people around the world. In 1938, Ehrenfried Pfeiffer's book '*Bio-Dynamic Farming and Gardening*' was published in German, English, Dutch, French and Italian, and represented for many years the standard work in the area. [8]

One of the most influential groups connected to the experimental circle later published a monthly journal with the title 'Demeter'. The agronomist E. Bartsch, who was a leading figure in this group, also founded the organisation Demeter to sell biodynamic products. This organisation later developed into the international certification Demeter International, establishing farming standards as well as standards for a wide spectrum of products including grain and dairy products, herbs and spices, meat and dairy products, beverages, and cosmetics. [9]

Biodynamic agriculture resembles organic agriculture in its rejection of mineral fertilisers and pesticides, and in its emphasis on working with the farm as an ecological organism, encompassing the soil, the crops, the animals, and the surrounding landscape. Additionally, biodynamic farmers use a set of preparations which Steiner introduced, for strengthening the plant from germination to ripening, and for optimising the composting process.

The present status of biodynamic agriculture, based on Demeter International certification includes more than 60 countries, with roughly 6,500 farms cultivating more than 220,000 ha, approximately 1,000 processing companies and 500 wholesalers. In 2020, the International Biodynamic Association (IBDA) and Demeter International joined forces to form the Biodynamic Federation Demeter International, an umbrella organisation which unites the farming movement, the certification work, and the market development work.

Apart from the Demeter International certification, various biodynamic associations have organised other certifications. Not surprisingly, when travelling around the world visiting biodynamic farms, due to the major differences in landscape and soil characteristics, as well as local farming traditions, biodynamic agriculture has many faces.

Also, not surprisingly, among both farmers and researcher, there has been an interest to compare the effects of different cultivation systems on the soil

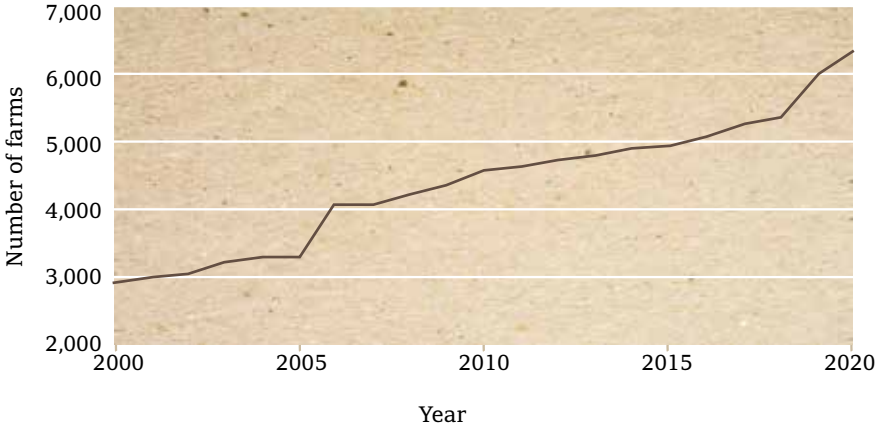


Figure 1. *Number of Demeter-certified farms for the years 2000-2020.* [8]

quality, as well as the crop and product quality. Here, one of the first systematic, comparative field trials took place already in 1971-1979, in a cooperation between the Swedish University of Agricultural Sciences and the Nordic Research Ring for Biodynamic Agriculture. The goal was to see in which way the two cultivation types influenced not least the crop quality.

Here, the biodynamic plots received a 'normal' level of composted stable manure, while the conventional plots received mineral fertilisers according to recommended standards for potato, wheat, and barley. A strength of this trial is that the same field experiment was carried out at two places, and that the results from the two places corresponded fairly well. A major finding was that the protein quality of the biodynamic crops was better, based on the content of essential amino acids, i.e., the amino acids which the human body cannot produce on its own, and which must be supplied by the diet.[10]

Since then, several larger, comparative field trials have been carried out around the world. Some have been carried out for only few years, while a few have been managed for more than 10 years. In 1978, the so-called DOK-trial was started in Switzerland, including both conventional, organic, and biodynamic cultivation systems. This trial is still ongoing and has contributed greatly to the scientific understanding of the long-term effects of different cultivation systems on the soil and crop quality. This field trial is presented on the following pages.

In Chapter 3, the many aspects of crop quality are described in more detail.

The DOK-trial

To get a first impression of the differences between conventional, organic, and biodynamic farming practices, let us look at an exceptional long-term field trial, the Swiss DOK-trial. This ongoing trial, comparing conventional, organic, and biodynamic cultivation systems, was started in 1978, and includes a total of 96 conventional (K), organic (O) and biodynamic (D) soil plots of 100m² (5m x 20m) in size. The crop rotation spans seven years, and each year three crops are grown at two levels of fertilisation (C1, C2; O1, O2; D1, D2; the numbers 1 and 2 mean 'normal' and 'high' levels of fertiliser, respectively). Here, the conventional plots are fertilised with a mixture of stable manure and inorganic NPK-fertiliser, the organic plots with stable manure, while the biodynamic plots are fertilised with compost.

The conventional treatments (C1, C2) are managed according to the regulations of 'integrated production', which also includes more sustainable elements such as the biological control of pests. Additionally, conventional 'mineral' cultivation is included, based exclusively on inorganic NPK fertiliser (M2; high level of fertilisation). Finally, a non-fertilised cultivation (N) is included. Each of these treatments are grown on four plots ('replicates') which makes it possible to reach statistically firm conclusions. Common crops such as clover, wheat, potatoes, maize, and soya are used. [11]

During the first years of the DOK-trial the main questions were whether the organic and biodynamic plots could produce acceptable yields, and if weeds and various plant diseases could be managed. Here, the results have shown beyond doubt that acceptable, high-quality yields can be achieved, and that weeds can indeed be managed with the necessary experience. In 2002, the research team managed to get an article published in the prestigious international journal Science, putting organic farming on the scientific map. [12]

Out of the numerous results published we will list here the major lessons which were learned concerning the long-term effects on yields and soil characteristics:

(a) The yields of the organic and biodynamic crops were around 20% lower than those of the conventional plots. Note here that the amount of nitrogen, phosphorous and potassium used for the organic and biodynamic plots were respectively 65%, 40%, and 45% lower.

(b) The organic and biodynamic plots require 30-50% less energy per unit area than the conventional plots, including energy used for producing the inorganic fertilisers and the pesticides. The use of energy per unit of yield is about 19% lower in the organic and biodynamic cultivation systems. Energy use is a widely accepted indicator of the sustainability of a cultivation system.

(c) The amount of soil organic matter – the brown humus – remained stable in the biodynamic system for the first 21 years of the trial, whereas it was reduced in the conventional systems, as well as slightly reduced in the organic systems. This is generally attributed to the use of compost instead of stable manure in the biodynamic system.

Biodynamic

Conventional mineral

(d) The biomass of earthworms in the organic and biodynamic plots is 30-40% higher than in the conventional plots. The total amount of microorganisms in the organic and biodynamic plots is 20-40% higher than in the conventional plots. Furthermore, the organic and biodynamic plants are more strongly colonised by mycorrhiza, i.e., there is a greater symbiotic cooperation between soil fungi and the plant roots.

Biodynamic agriculture and spiritual science

Biodynamic products are often praised by chefs for their excellent quality, with biodynamic wines being awarded many more awards than would be expected, considering the low number of biodynamic wine growers, as compared to organic. However, in general natural scientific researchers do not wish to examine the spiritual background of biodynamic agriculture. Here, we should learn from history. Science, as we know it today, was introduced in the Middle Ages by courageous people who confronted the dogmas of the Catholic Church. For this opposition, several people paid with their lives at the hands of the Pope's Inquisition. Galileo Galilei, who is seen as one of the fathers of science, invited the Pope's cardinals to look through his telescope and to see for themselves the moons of Jupiter. The cardinals declined his offer, since the Church's dogmas about the Earth and the Universe ruled out the observations claimed by Galilei. Later, he was found 'heavily suspected of heresy' by the Inquisition and spent the rest of his life under house arrest. There, he continued his scientific work, and later stated that scientists should only 'count, measure, and weigh'.

The discoveries and achievements of natural science are impressive, ranging from the sub-molecular level and into the farthest astronomical regions of the Universe. The sophisticated technologies which surround us in our everyday lives are also based on natural science. However, the challenge of natural science is not only to look outward into atoms and galaxies, but also to examine the human mind with an unprejudiced mind. Then, the basic phenomenon of clairvoyance will be seen as a true phenomenon, i.e. the ability of humans to describe the spiritual forces which are active in nature, the landscape and in the soil, plants, animals, and humans.

Rudolf Steiner, the founder of biodynamic agriculture

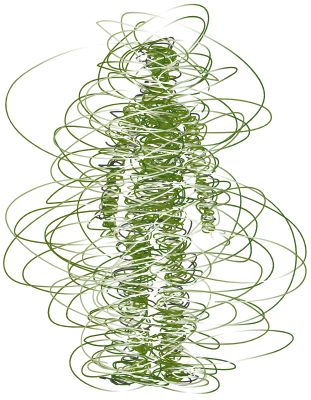
This clairvoyant ability was mastered by Steiner to an exceptional degree. He was born in 1867 in the Austrian-Hungarian Empire. He studied mathematics, physics, chemistry, and natural history at the Vienna Technical University, as well as philosophical topics at the University of Vienna. In 1901, he spoke publicly about spiritual topics for the first time. From 1902-1912 he was General Secretary of the German Theosophical Society. In 1912, a group of his co-workers founded the Anthroposophical Society. In 1919, the first Rudolf Steiner School was established in Stuttgart, with an educational programme

which today is taught in more than 2,000 schools worldwide. Over the following years, he gave impulses for several areas of life, including architecture, medicine, banking, organisation and company development, drama, art, and not least agriculture. In 1923-1924, he initiated the founding of The General Anthroposophical Society, as well as a School of Spiritual Science as a modern initiation centre. After a long period of illness, he died in March 1925. Of his work 25 books and more than 6,000 lectures have been preserved to the present day.

Steiner's key statements were that a spiritual world exists in parallel to the physical world, and that the development of both is deeply interconnected. Human insight into the spiritual world can be achieved with the same objectivity used to make observations and judgements in the physical world.

Today, anyone with sufficient will and endurance can develop spiritual insight, based on objective thinking, specific exercises, and moral practices. When taking specific precautions, the individual can avoid the lack of objectivity which characterised the earlier, inherent access to the spiritual world. Based on such a 'new' clairvoyant, spiritual insight, Steiner described the human as a four-folded being, including the following four 'bodies':

The physical body

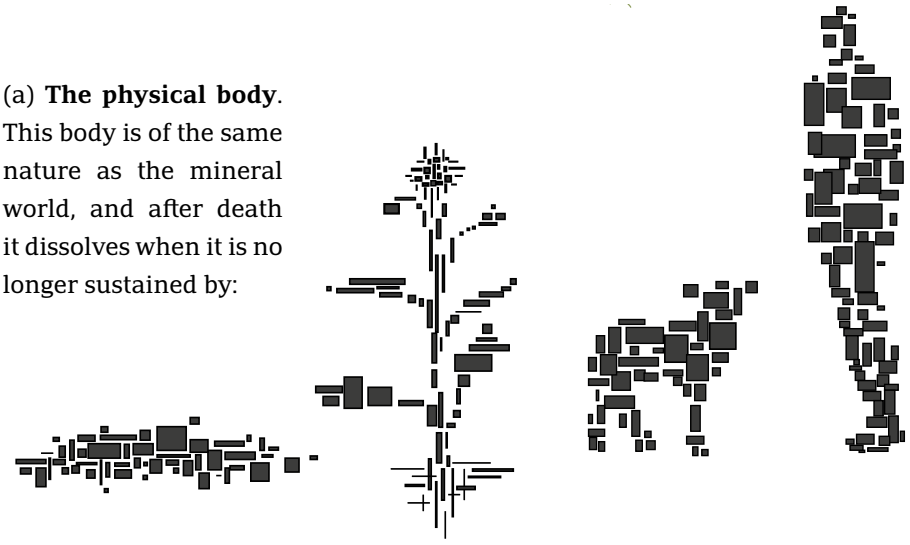


The life body

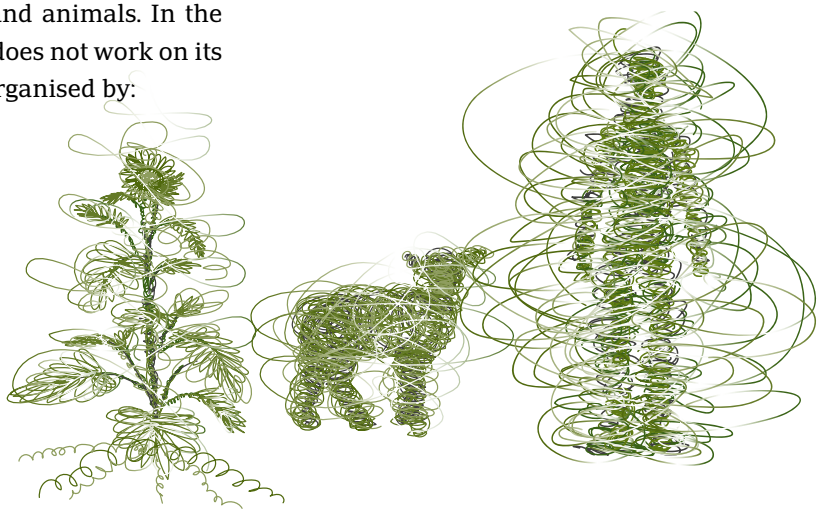
The consciousness body or the astral body

The self-awareness body or the individual I

(a) **The physical body**. This body is of the same nature as the mineral world, and after death it dissolves when it is no longer sustained by:



(b) **The life body** or the etheric body. This body completely permeates the physical body and maintains all the physical organs and limbs, which also correspond to those of the physical body, only more complicated in structure and in constant movement. All living organisms in nature have an etheric body, including plants and animals. In the human being this body does not work on its own, but is constantly organised by:



(c) **The consciousness body** or **the astral body**. This body is the carrier of consciousness, of emotions and sentience, and of sympathy and antipathy which are set in motion in the meeting with the outer world. In the animal this body is intimately connected to its instincts, whereas a human being is potentially able to regulate and further develop the astral body by means of:

(d) **The self-awareness body** or **the individual I**. This is what brings a feeling of something lasting into the human soul. Animals do not have an individual I, whereas the human is an individual due to the presence of the I. This I makes possible human self-awareness. Here, human health depends on the harmonious function of the individual bodies, as well as on a harmonious interconnection between the bodies. In Steiner's books and lectures, these processes are described in detail. [13,14]

In former cultures all humans had clairvoyant abilities. Thus, in the old Indian yogic tradition the etheric forces were called 'prana', and in the old Chinese medical traditions these were called 'chi'. Clairvoyant people can be found all over the world; however, an ability to give an objective description of the phenomena observed is only found when they have undergone a long spiritual training process. A few natural scientific researchers have taken up the challenge of examining the human clairvoyant abilities.

The work of Shafica Karagulla

The most prominent of these was Shafica Karagulla, who in the middle of a brilliant medical carrier started investigating the human 'higher sense perception'. In 1967, she published a book, including case studies of clairvoyant persons who were asked to describe the 'energy fields' of humans. [15] One of these clairvoyants was repeatedly confronted with fully dressed, anonymous hospital patients, without any pre-knowledge of the patients' medical history, with the task of describing their energy fields as well as proposing a diagnosis. According to the descriptions of the clairvoyants studied, human beings have, in addition to the physical body, three energy fields which are invisible to the physical eye. Thus, the human being is composed of these four elements:

(a) **The physical body**.
(b) The **'vital field'**, extending about two inches from the human physical body, blue-grey in color. This is what carries the life processes.
(c) The **'emotional field'**, which has colours which change according to the psychological state of the person, extending approximately 30 cm from the physical body.
(d) The **'mental field'**, which is ovoid like the 'emotional field'; however, it is considerably larger and less dense, with colors reflecting the individual's mental interests and abilities. [16]

The descriptions given by experienced clairvoyants illustrated that these could in most cases give a relevant diagnosis after examining a patient's energy fields. In 1969, Karagulla was appointed director of research of the Higher Sense Perception Research Foundation in California. Later, she published another book together with a woman who was born with exceptional clairvoyant abilities. The conclusion from the case studies was that clairvoyance can be a helpful diagnostic tool, and that the key to human health and disease lies in the dynamic interaction between the energy fields and the vital, emotional, and mental field, relative to the surrounding universal energy fields. And that the interactions between the physical body and the chakras - the spiritual energy 'centers' - take place via the endocrine glands, as well as the bodily organs such as the thymus, pancreas, adrenals, and the spleen. [16]

The descriptions given by Karagulla and Steiner are strikingly similar. However, Steiner's description of the human being is integrated into the overall spiritual science. In contrast to this, Karagulla saw her task as collecting descriptions of the human energy fields from experienced clairvoyants, and to

point to the potential of clairvoyance as a medical, diagnostic tool as the first step towards a broader scientific acceptance of the human energy fields and higher sense perception.

The whole is more than the sum of the parts

Imagine the numerous single parts of a car lying on the floor in front of you. With some experience you may be able to assemble them into a ready-to-drive car. Further, when it is reassembled, you can take the car apart again without its mechanical functions being lost. In contrast to this, you cannot take a crab apart, place its legs and body on the sand and then reassemble the parts into a 'ready to live again' spider. In living organisms, the whole is more than the sum of the parts, and they play tricks with our perception. The bee flying around in the summertime is a living organism, but ultimately it is an optical illusion to think of the individual bee as a separate organism. The bee is a 'cell' in the bee family.

In organic and biodynamic agriculture, farming is seen as an integrated part of nature's ecosystems. Here, the living, fertile soil is the basis for cultivation, and the interactions between the crop and the soil organisms are crucial to

The two images above illustrate the loss of meaning which takes place when a complex whole is reduced too strongly into single parts. The image on the left shows an arrangement of lines of different size, shape, and color. The picture on the right shows the same lines, but here the inner context and 'meaning' between the lines is visible. The picture shows a cat.

the health of the crop. This contrasts with conventional agriculture, including aquaponic production systems, which do not represent an ecosystem approach to agriculture. Instead they represent an industrial approach. This polarity between conventional agriculture on one hand, and organic and biodynamic agriculture on the other, is not just about chemical inputs or degrees of industrialisation. It reflects a more deep-rooted difference in the view of nature and its organisms.

Reductionism and holism

We can find this polarity in all areas of life and science, one which in philosophy is termed reductionism versus holism. Thus, conventional farming is one part of the polarity, whilst organic and biodynamic agriculture represent the other. Reductionism is about reducing complex organisms, interactions, and interdependencies into single, measurable, and replaceable parts. Holism is about identifying the structures and the interconnectedness between the individual parts which cannot be fully explained by the properties of the individual parts.

When walking in nature with a holistic attitude, we will experience 'this is a forest', while with a reductionistic approach we will experience 'this is a num-

ber of trees'. A word is made up of letters which individually do not have a 'meaning'; however, when combined, suddenly they have a meaning. A sentence is made up of words which individually have a meaning, but the sentence has an overall meaning, which overrules or modifies the combined meaning of the individual words. An overall meaning has appeared which may again be changed, depending on our pronunciation and facial expressions. The whole is constantly affected by its single elements, and vice versa.

Reductionist scientists will argue that the holists are too busy looking for forests to see the individual trees. Conversely, holistic scientists will argue that science is full of examples of how easily we draw wrong conclusions when we ignore the more complex interactions at play. The chromosomes and genes of living organisms have been called 'the alphabet of life' since the DNA macromolecule was mapped in the 1950s. The dogma was then: 'One gene codes for one protein in charge of one life process'. For decades, the general expectation has been that we as humans have 100-120,000 genes, corresponding to the estimated number of life processes in our body. But when the human genome was mapped, after tremendous scientific efforts, it turned out that humans have around 25,000 genes! This roughly corresponds to the number of genes in a housefly.

Thus, the general perception of genes was evidently wrong. The individual life processes of living organisms are not controlled by a single gene, but by a combination of several or even numerous genes via hidden 'networks'. Today, genetic scientists are busy trying to map these networks, by means of ever more powerful computers and statistical analyses.

Another phenomenon has brought about a fundamental change in the scientific view of genes. It was discovered that certain bacteria can continue

living even when their genes have suffered massive damage from X-ray or gamma-radiation. It is well-known that these two types of radiation are very harmful to humans due to the damage which they inflict on our genes. Just 10 gray - a radiation unit – can be lethal to humans. It was found that a certain bacterium – *Deinococcus radiodurans* – could withstand 17,000 gray without dying, despite massive damages to its genes and DNA structure.

Amazingly, this bacterium is somehow able to repair this damage. Exactly how it can make head or tail of the damaged genes is a major puzzle to scientists, but it can indeed manage this as long as certain proteins have not been destroyed. [17]

Our nutrition – nutrients or living foods?

What does all this have to do with food quality? Let us take an example from the conventional milk processing industry. For decades, dairies have regulated the fat content of fresh farm milk, as well as pasteurising and homogenising the milk. However, today's dairy researchers are working hard to develop 'designer milk', whereby the milk is completely separated into its individual substances: lactose, proteins, fatty acids, nitrogen compounds, minerals, and water. Subsequently, these are 'reassembled' into a broad spectrum of products, intended to match the individual needs and wishes of consumers. Here, the milk is seen as the sum of its parts, just like a car is the sum of wheels, engine, gears, brakes etc. It is assumed that the milk can be separated into its parts and then reassembled without a loss of health properties. [18]

With a holistic approach, we may assume that designing milk in this way will reduce the nutritional quality of the milk; however, this has not been investigated in any detail. Still, we know that positive health effects can show up when we work with a more holistic approach for say cancer treatment. Several combinations of secondary compounds have been tested, and a 'super-cocktail' of six compounds has been found which can kill 100 percent of breast cancer cells in a cell culture. All six compounds are antioxidants, including four compounds which are found in common vegetables such as cabbage and celery, and in addition curcumin from the spice turmeric, and resveratrol from red grapes. The six compounds are not highly effective when applied individually, but as a cocktail, they give a stunning effect, presumably by combining effects on different aspects of the cancer cell division. Furthermore, no

harmful effects were found when this cocktail was applied on healthy cells. [189 The whole is more than the sum of the parts.

In the next chapter, we will look at the cornerstones of biodynamic agriculture. We will see that the question of food quality and health grows in complexity when we include the spiritual basis of biodynamic agriculture.

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The cornerstones of biodynamic agriculture

2

In this chapter we will look at the characteristics which together shape the identity of biodynamic agriculture. Organic and biodynamic agriculture share many characteristics in terms of daily farm activities, yet while organic agriculture is based on natural science, biodynamic agriculture is based on spiritual science. Both the practical and spiritual aspects of the cornerstones of biodynamic agriculture will be presented.

The living soil

In the Agriculture Course, Rudolf Steiner stated that the task of spiritual science in relation to agriculture is to offer a means of treating the manure in such a way that the soil will be enlivened, so that the plant can grow in a living soil and reach its fruit formation [1]. With these words, Steiner pointed out three cornerstones of biodynamic agriculture: the living soil, the biodynamic compost preparations, and the fruit formation of the plant. In addition to these three cornerstones, three more can be added. Let us start with the living soil.

Around the world we find several types of soil: sandy, clay, chalk, bog, brown, black and others. It is humus that makes all these soils fertile. The black-brown humus is the last step in a long process whereby plant residues and animal manures are broken down by earthworms and microorganisms and transformed into fertile humus crumbs. These are made up from clay particles and minerals, together with organic compounds which glue the whole thing together. Take a handful of fertile soil, and you can see the crumbs with your eyes, and feel them with your fingers. In a fertile black-brown soil, there may be 5-6 percent humus, and in extreme cases you may find garden soils with up to 10 percent humus. As the humus increases, so does the fertility of the soil, its ability to bring forth crops.

The chemical and biological processes which bring about the humus may sound simple, but they are far from that. Soil scientists openly acknowledge that they do not fully understand the complexity of humus. The quantity and quality of the humus is also the result of the work of numerous generations of hardworking farmers who have brought manures and compost on to the fields, tilled the soil and carefully worked with the right crop rotation.

The experienced farmer works with a carefully balanced rotation between crops to build up the humus, using for example clover, and on the other side cash crops such as wheat, which draw on the humus pool. An optimal crop rotation will supply the farm animals with abundant and healthy fodder, will generate cash crops, and on the top of this will slowly build up the soil fertility.

Some crops have relatively shallow root zones, while others can penetrate more than 10 metres down, bringing up water and valuable minerals to the surface. Some crops grow slowly, while others grow so fast that they can be

sown after the main crop has been harvested. Such crops can capture and utilise the available nutrients in the soil, especially nitrogen, so that these are not washed out during a wet autumn and winter. Some types of humus, with a relatively high content of nitrogen, are rapidly broken down by microorganisms and transformed into plant nutrition. Others, with more cellulose-like compounds and hardly any nitrogen, may be stable for decades and only specific fungi can break down these stable structures. With the right amount and quality of humus, the soil will be porous with plenty of oxygen available for the roots and microorganisms, and with a maximum of plant nutrients which are not leached away by heavy rain.

In intensive conventional agriculture, the crop rotation is replaced by cash crops grown in the same fields every year, whereby the humus content is slowly eroded. At the same time, animal manure and compost are replaced by inorganic fertilisers, which accelerate the erosion of the humus. Depending on the original soil fertility, as well as the intensity of the conventional cultivation system, this process may take 100 years or more.

However, at some point the humus capital in the soil bank has been used up. Then, in the spring, storms may raise clouds of light-brown particles, ending up on roads, buildings, and tractors. The humus soil has lost its inner coherent structure and is blown away. This is especially the case with sandy soils. On the other hand, when conventionally managed fields are converted to organic or biodynamic agriculture, already after only a handful of years they will have improved visibly. The number of earthworms increases, the crumb structure returns, and the tractor needs less power to pull the plough through the soil.

A scientific review of long-term trials from around the world concluded that the organic systems had between 32 and 84 percent greater microbial biomass, as compared to conventional systems. [2]

We saw earlier that in the DOK-trial organic and biodynamic soils are better at preserving and building up the humus content than conventional ones. Thus after 21 years of cultivation the humus content had increased in the biodynamic plots which were given a larger amount of compost. In contrast, in the conventional plots the content of humus had decreased, and in the organic plots the humus content had remained relatively stable over the years. The trial also showed that the overall soil biological activity had increased the most in the biodynamic plots.

The blind magicians of the soil

A highly fertile soil contains a multitude of earthworms. Under our Western European skies, we mostly find three groups of earthworms: (a) those which live in the compost and the highly active top layer of the soil; (b) those which live in the brown, arable soil; and finally (c) those which make deep holes below the humus soil, as far down as two metres. The earthworms in the arable soil are 10-18 cm long, they are reddish-brown, live for two to three years, and they are the ones which the birds eagerly strike down on when the plough has turned the soil. They have a lot of valuable proteins and fats, which is why chickens are most eager to search a soil which has just been turned over.

These earthworms belong to the *Lumbricus* species. At night they draw plant residues and other materials from the soil. In their digestive tract these are mixed with mucus, tiny clay particles and quartz granules with the acidity of the material being regulated by means of chalk-producing glands. Finally, they leave behind tiny, round 'compost heaps' containing nitrogen, minerals, trace elements, plant hormones, as well as mycorrhiza fungi. The tiny heaps are also full of beneficial bacteria from the earthworms' intestine, and for the plants these heaps have a nutritional value which may be five times larger than that of the surrounding soil. The holes and channels which the earthworms leave in the soil are lined with valuable mucus, which makes it possible for both roots and heavy rain to pass easily through the soil.

As humans we daily eat and drink about one twentieth of our body weight, but earthworms may eat up to half of their weight. In fact, they do not live from manure or plant residues, but instead from the microorganisms living on these organic materials. The earthworms clean the soil by eating up harmful microorganisms which die on the way through their intestinal system. They prefer soils with a certain amount of clay since in more sandy soil their channels will more easily collapse.

A fertile soil may easily host 7-8 tons of earthworms per hectare, and up to 20 tons of fungi and bacteria, as well as countless insects, all contributing to the soil life. This amount can be compared to the weight of the farm animals per hectare, which in general adds up to one ton of animals per hectare. In the Agriculture Course, we find the following remarks on the earthworm: 'Study the earthworm – how it lives together with the soil. These worms are wonderful creatures. They leave to the earth precisely as much etheric activity as it needs for the plant growth. There, under the soil surface you have the earthworms and similar creatures distantly reminiscent of the larva. Indeed, in certain soils – which you can easily tell – we ought to take special care to allow for the due breeding of earthworms. We should soon see how beneficially such a control of the animal world beneath the soil would react on the vegetation, and thus upon the animal world in general.' [3]

A personal connection to composting

Steiner emphasised the need to work with the enlivening of the soil: 'We must vitalise the *earth* directly, and this we cannot do by merely mineral procedures. This we can do only by working with *organic* matter, bringing it into a condition that it is able to organise and vitalise the solid earthy element itself. To endow the mass of manure, or the liquid manure, with this kind of quickening or stimulus, is precisely the object of those inspirations which we are able to give to agriculture out of spiritual science'. [4] We hereby come to the composting process, and to the necessity of building a personal connection to composting.

In conventional agriculture composting of animal manures has nearly disappeared. After the Second World War inorganic NPK fertilisers gradually took over and farmers lost interest in giving animal manure the attention which it had been given in earlier times. Manure is still appreciated for certain crops; however, composting is seen as being too labour intensive. Later, the use of slurry – a mixture of solid manure and urine – forced composting even further into the background.

In contrast to this, in biodynamic agriculture composting is universally regarded as the optimal way of treating animal manure. A broad spectrum of techniques for composting are used around the world to reflect the different local conditions, the number of animals on the farm, as well as the available hands. From scientific investigations we have much information concerning different composting techniques and the effects on the humus content and soil quality. However, we have hardly any results documenting the connection between the composting and the health of the animals.

A pioneer in the art of composting

Here, the work of Albert Howard (1873-1947) is worth studying. He was inspired by Rudolf Steiner, yet he did not work with biodynamic agriculture; instead he was one of the pioneers of organic farming as we know it today. He worked for years as an agricultural consultant in India, including being director of a research and extension station in the town of Indore in the 1920s. He has documented in detail his work with composting, so that we can follow the 'red thread' from the composting via the crops to the health of the cows at

the research station. This composting technique later became known as the 'Indore compost' [5]. A few years before his death, he published the book 'An Agricultural Testament', in which he summarised his work. [6]

From the start, Howard studied the cultivation practices of the local farmers, and he was determined to offer them something which they could manage both economically and practically. He could easily have introduced tractors, inorganic fertilisers and new high-yielding varieties, but instead he arranged the research farm like a typical Indian farm, growing all the local crops, working with the same work oxen as the local farmers, and feeding them exclusively on fodder from the research farm.

After some time at the Indore research station, he concluded that the district's soils were potentially fertile; however, they were low in organic matter and nitrogen due to the farmers' insufficient care for the cow manure, the crop residues, and the household green waste. During his many travels in India, he had noted a striking connection between the local farmers' care for the soil and the manure on the one hand, and on the other hand, the health of the local population. He concluded that there was an intimate connection between the care for the manure and the soil, and the health of the crops, animals, and the local population. To summarise this finding he declared: A healthy soil gives healthy plants which give healthy animals and humans.

After a long time spent observing and experimenting, Howard had fine-tuned the 'Indore compost', and he also integrated the latest knowledge on soil microbiology. Thus, he was able to produce a high quality, organic fertiliser in which the amount of nitrogen was higher than that of the starting materials, and the amount of soil humus in the fields slowly increased. Already after a few years he could document record yields, an absence of plant diseases and damaging insects, as well as healthy cows. Soon, farmers would come from all over the region to see with their own eyes composts and fields crawling with earthworms, as well as healthy crops and well-nourished cows with shiny skins. Not least, the visitors were surprised to hear about the immunity of the cows in connection with an outbreak of foot and mouth disease in the region. This feared, contagious cattle disease rapidly spread across the region, but Howard did not instruct his co-workers to take any special measures. Consequently, the cows at the research farm continued rubbing their mouths with the infected neighbouring cows across the fence. Not a single cow at the station was infected.

Howard emphasised the importance of ensuring the reproducibility of the ingredients, like with bread-baking recipes. All available organic materials should be used, including animal manures, bedding straw from the cattle shed, crop residues, leaves, forest waste, woody materials, weeds, green manures grown especially for composting, wood ashes, clay which is able to absorb ammonia, compost soil serving as inoculation material, and 'urine earth' saturated with urine from the work oxen. The cattle manure should be fresh, so that the cellulose-rich materials can be quickly decomposed by rumen bacteria and enzymes.

The weight ratio between the manure and the remaining materials was about 1:4, and the goal for the final compost was a C/N (carbon/nitrogen) ratio of 10:1. The individual compost was made up of layers of manure and mixed, moistened vegetation material. The process was arranged to be both aerobic and rapid, with a temperature not exceeding 65°C. Thus, weed seeds, harmful fungi and insect eggs would be killed, but not the useful microorganisms, and no nitrogen would be lost. The compost was turned three times, including an additional inoculation with older compost material, thereby bringing the composting process to the next stage. The compost was covered so that there was no smell at any stage and no breeding of flies. After three months the compost was ready and was spread immediately on the fields.

When asked if specific details could be omitted, Howard would answer that the point was to develop a procedure which matched the local conditions and available materials. Thus, the critical challenge for the farmer is to get a personal grip on the composting process, thereby starting the process towards creating a healthy soil that gives healthy plants and thus healthy animals and humans.

From desert sand to fertile soil

In biodynamic agriculture, the challenge is essentially the same. Steiner emphasised that the farmer should develop a personal connection to everything on the farm, but especially to the manure. The farmer must arrange the compost process so that it unfolds some of the essential characteristics of an organism, one with less strict 'borders' than trees and lions, yet an organism going through different life stages, ending up as fertile humus. For this, the biodynamic farmer has at his/her disposal the biodynamic compost preparations which hold a potential for improving the compost process beyond what Howard managed.

Today, a living example of the potential of composting can be found in Egypt, at the SEKEM Initiative. In 2015, the place won the prestigious UN 'Land for Life Award' which is given to special initiatives working to stop desertification and to create a combination of social, cultural, and sustainable progress. Since 1977 more than 2,000 hectares of desert land have been converted into cultivated land. In 2012, SEKEM founded the Heliopolis University for Sustainable Development. In 2020, 24 students attended the course on biodynamic agriculture. [7]

Originally, the founder Ibrahim Abouleish bought 70 hectares of desert 60

km northeast of Cairo. Since then, the speed of development at SEKEM has been breath taking, including kindergartens, schools, an adult training institute; the production and export of fresh vegetables, fruits, medicinal herbs, and tea herbs; co-establishing an independent certification body for organic and biodynamic farms; and founding the Egyptian Biodynamic Association, together with agricultural training and extension services. Today, more than 2,000 people go through the main entrance on working days.

All this has been possible due to the systematic production and use of compost. During the first years, organic materials were brought in from the surrounding areas. Today, 8,000 tons of compost are produced on site annually, based on manure from roughly 270 cows, as well as sheep manure, crop residues and

green kitchen waste. At the beginning, the sandy areas were given 40-50 tons per hectare per year, while today it is around 10 tons. The composts are supervised thoroughly, not least to ensure that the temperature does not rise above 65 °C. To achieve this, watering as well as repeated turning is necessary. This composting procedure has over the years created a humus layer of nearly 30 cm. A balanced crop rotation has been introduced, ensuring that the soil is kept green all year round.

Recently, SEKEM invested in a new area of 900 hectares, roughly 100 km from Cairo, in the middle of the West Egyptian desert, near the oasis town of Bahariyya. The ability of SEKEM to generate not only arable land from desert sand, but also significant social, cultural, and economic activity, has made the place well-known worldwide. Not surprisingly, the development at SEKEM has been closely followed by the Egyptian authorities, who are facing an enormous challenge in feeding Egypt's population. Between 1960 and 2017, the population grew from 27 to 97 million people! Egypt was once called 'the grain chamber of the world', exporting wheat in all directions, but today the once fertile land along the River Nile has been severely polluted by pesticides from intensive, conventional cotton production. The question is to what degree the example of SEKEM can be implemented in other areas in Egypt, as well as in other countries with desert areas.

The biodynamic preparations

We now come to what many see as the main cornerstone of biodynamic agriculture, the biodynamic preparations. In the Agriculture Course, Steiner briefly described how to produce and apply two groups of preparations. Today these are referred to as preparations 500 and 501, and preparations 502-507, respectively. The preparations 500 and 501, also termed the field preparations, are used as field sprays on the soil and the crop, whereas preparations 502-507, also termed the compost preparations, are used for compost. [8]

The starting point for the preparations is two-fold. Firstly, all agricultural and horticultural plants take away both nutrients and forces from the soil which must be replaced, in order not to slowly erode the soil fertility. Secondly, according to Steiner, today's plants have lost a major part of their earlier vitality and nutritional value so that it is necessary to support these aspects of the plants. Let us start with a description of how the preparations are produced and how they work. The two field preparations 500 and 501 – also termed the Horn Manure and the Horn Silica preparation, respectively - are presented in some detail below. These descriptions partially reflect the experiences and practices of today.

The field preparation 500, Horn Manure

A mini compost with enhanced spiritual activity

The Horn Manure preparation (500) is made from fresh cow manure, which is stuffed into cow horns in the autumn and buried in a fertile soil during the winter half-year. The manure should come from local cows which have calved and havegrazed on pasture. The manure should be firm, even to the point where the intestinal peristaltic movements are reflected in the outer form. When the horns are dug up in the spring, the manure has undergone a process, whereby microorganisms, together with etheric and astral forces in the soil, have transformed the manure into a dark-brown, humus-like substance.

When compared with an ordinary manure compost, more types of microorganisms are active in the preparation. Generally, an egg-sized portion is used per hectare. The final preparation is stirred rhythmically and intensively for one hour in a suitable 'barrel' until a deep vortex appears. Then, the stirring direction is quickly reversed, whereby chaotic movements arise until a new vortex appears. The preparation water is sprayed as droplets on the soil in the late afternoon.

Steiner's clairvoyant description of the Horn Manure preparation is roughly the following: In human faeces, the amount of nutrients, as well as the remaining

The field preparation 501, Horn Silica

spiritual forces, is very low, since they are to a large degree taken up during our digestion. In contrast to this, a substantial amount of nutrients is found in cow manure, and we also find a strong activity of both etheric and astral forces which are available to the plant. Furthermore, in the soil itself we find active etheric and astral forces not least during the winter half-year. Here, the horn material has the characteristic that it does not allow etheric and astral forces to pass through, but instead these forces are reflected back into the horn. Thus, when we place the horn in the soil, the etheric and astral forces of the manure, as well as some from the surrounding soil, will be accumulated in the horn. This means that the final, composted preparation radiates strongly etheric and astral forces. Through the compost, this preparation can enliven the soil, as the basis for the plant to grow in and to reach its fruit formation.

Three Italian farms carried out a scientific study on the chemical and microbial properties of the Horn Manure preparation. They concluded that the preparations contained a considerable enzyme activity, related to the four nutrients carbon, nitrogen, phosphorus and sulphur; a high number of bacterial species as well as fungi, representing a potential for stimulating the soil microbial flora; and bio-active compounds with a well-known growth-hormone effect on plant roots. [9]

Silica with an enhanced spiritual activity

The Horn Silica preparation (501) is made from finely ground quartz crystals, with the consistency of fine flour. This is moistened with water, stuffed in cow horns, and buried in a fertile soil during the summer half-year. In the autumn, the horns are dug up. The contents are then placed in a glass jar, and kept in a place which is exposed to the morning sun. Approximately 1g is used per hectare. The preparation is stirred rhythmically and intensely in water for one hour, as described for the Horn Manure preparation. The preparation water is sprayed as a fine mist over the crops and pastures, in the early morning of a sunny day during the ripening stages of the crops.

Considering the extremely low water-solubility of quartz, as well as the minute amount of preparation used per hectare, we cannot expect any direct physical effect, such as when spraying a copper solution on fruit tree flowers to prevent fungal growth. Instead, we may say that the etheric, astral, and higher spiritual forces from the preparation have been transferred to the water and brought

into connection with the molecular structure of the water. The water has been 'dynamised'.

The ability of silica to take up light can be shown by a simple experiment. From a natural area on which you find pure sand at a minimum depth of 1 metre, dig up say 500kg of sand during the early summer. The point is that the sand has not for thousands of years been exposed to sunlight. You divide this sand into two parts, one which is immediately stored in a cool, totally dark cellar, and one which is spread on a clean, sunny place during the summer. In the late autumn, in a place which is protected from rain, dig two rectangular holes, say 1x1 metres, with a distance of a few metres between them, and each with a minimum depth of 50cm. At the bottom place some straw, and on top of this the two different types of sand which have been moistened beforehand with water to a comparable level. In each of the sand layers you place say 50 ripe acorns, after which the sand is covered carefully with dark plastic film and subsequently boards, so that no sunlight can shine on the sand.

Then, next spring you remove the upper materials from the two holes, and take out the acorns from the sand. When comparing the germinating acorns from the two types of sand, you will notice that the leaves of the acorns placed in the sand which had been exposed to sunlight during the summer are green. In contrast to this, the leaves of the acorns placed in the sand in the other cellar are white, a colour similar to what you see when potatoes have germinated in darkness. Clearly, silica has an ability to store and release sunlight. [10]

The preparation promotes the light metabolism of the crop, including the formation of chlorophyll for photosynthesis. It promotes the ripening of the crops, as reflected in the dry matter content, the sweetness, the fragrance, the shelf life, as well as the content of essential oils. Several people have reported that the Horn Silica preparation gives an effect which can be observed directly within a few hours after spraying. This effect is most easily observed for plants with big leaves, such as members of the Cucurbita family, including cucumbers. Here, the leaves may lift their outer areas slightly towards the sunlight, thereby appearing more bowl-like [11]. In order that a watering effect can be ruled out, the plants must be fully supplied with water. So far, no systematic, scientific study of this phenomenon has been published.

Dose-response effects versus more 'holistic' effects

Biodynamic researchers have for years been puzzled by the fact that in some years the combined effects of the two field preparations showed a positive effect, whereas in other years no such effect was seen. Finally, when reviewing the combined bulk of results, these uneven results made sense from the perspective that in case of a surplus, of especially nitrogen, the yield will be held back, whereas in case of nitrogen deficiency the yield will increase. Thus, the effect of the preparations is not a simple dose-response effect, but instead a 'normalisation' of the growth and yield. Here, the soil, the plants and the environmental conditions together form a complex living system, an organism of a higher order which is influenced by the preparations. [12]

I can illustrate the measurable effects of the Horn Silica preparation based on my own first years in biodynamic research. I participated in a field experiment examining the effect of the preparation on the ripening of carrot and white cabbage. Here, they were cultivated at two levels of fertiliser ('normal' and 'high'), and sprayed 0, 1, 3, or 6 times with the Horn Silica preparation. After harvest, an independent laboratory analysed the carrot samples for their content of free amino acids, which are found in the plant sap and have not been transformed into proteins. The results showed a systematic, inverse correlation between the growing number of Horn Silica sprayings and the content of free amino acids. Thus, the Horn Silica preparation promoted the ripening of the carrots, the content of free amino acids decreased, and in parallel the content of fully developed proteins increased.

Similarly, after five months' storage, the white cabbage samples were evaluated visually by three people for their marketability, based on the degree of microbial attack and 'fresh colour'. The results documented that the cabbages which had been sprayed 3 or 6 times showed less microbial attack and had a fresher outer appearance. Thus, the preparation promoted the storage ability, as an integrated aspect of ripening. The experiment was undertaken to inspire Danish biodynamic farmers to work with the preparations and was not intended for scientific publication. As such, critics may rightfully reject the results as non-valid documentation. In any case, the clear results became a major inspiration for our research association and their impact has remained with me until today.

A compost – a living, sentient organism

Let us continue with the six compost preparations (502-507), starting with the materials from which they are produced.

- The Yarrow preparation is made from the flowers of *Achillea millefolium*.
- The Chamomile preparation is made from the flowers of *Matricaria chamomilla*.
- The Stinging Nettle preparation is made from both stem and leaves of *Urtica dioica* at the initial stage of flowering.
- The Oak Bark preparation is made from bark of the oak *Quercus robur*.
- The Dandelion preparation is made from the flowers of *Taraxacum officinale*.
- Finally, the Valerian preparation is made from sap pressed from the flowers of *Valeriana officinalis*.

Surprisingly, Steiner stated that of these six preparations only the Stinging Nettle has unique, irreplaceable abilities, meaning that this plant cannot be replaced by any other. This preparation promotes the ability of the plant to adapt to changing growth conditions in a specific soil, and thus avoid harmful processes. With sufficient clairvoyant insight additional preparations can indeed be developed. A few people have proposed such additional preparations, however none of these have found a wider use in biodynamic agriculture. [13]

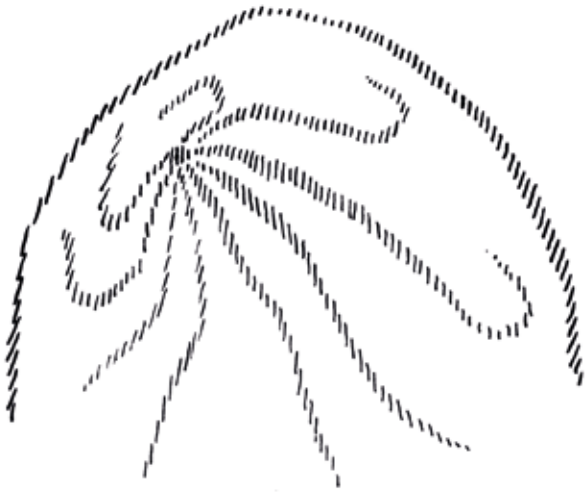

Figure 1. *How the spiritual forces from the compost preparations spread out in the compost. From a board drawing made by Steiner during the Agriculture Course.* [1]

Concerning the use of animal organs – a stag's bladder for the Yarrow preparation, the small intestines of a cow for the Chamomile preparation, a cow skull for the Oak Bark preparation, a cow mesentery for the Dandelion preparation - this does not have the purpose of reflecting etheric and astral forces into the organ, such as was the case with the horns for the two field preparations. Instead, the goal of including these organs is to strengthen the ability of the preparations to work with specific etheric and astral forces.

Regarding the other preparations, Steiner remarked concerning the Yarrow preparation that it enables the final compost to enliven the soil, and to make it 'sentient' in such a way that it can absorb from the air homeopathic amounts of silicic acid, lead, and other substances. The Chamomile preparation enables the plant to avoid harmful fruit processes and strengthens the general plant health. The Oak Bark preparation promotes healing processes in the plant, including reducing an excess of etheric forces relative to the astral forces. Finally, the Dandelion preparation promotes the ability of plants to utilise nutrients and forces from a large sphere around them.

How can we connect these descriptions based on clairvoyant insight with what natural science tells us about plant growth? Let us take the Dandelion preparation as an example. Rudolf Steiner described that plants must have a kind of sensitivity, whereby they can 'attract' what they need from the surroundings. Here, the Dandelion preparation will enable the plants to benefit from what is in the nearest meadow and small forest. It is not clear what Steiner here means by 'attracting', and at the time of the Agriculture Course, this hardly made much sense to the audience of farmers.

However, in the 1950s researchers discovered a symbiosis between plant roots and mycorrhiza fungi. These fungi have an interconnected mycelium which can extend literally over hundreds of metres. In a symbiotic relationship, the fungi supply the plants with minerals and nutrients which are not accessible to the plant, due to distance or to an insoluble state in the soil. In return, the fungi receive glucose from the plant, a crucial compound which they cannot produce themselves since they have no photosynthesis. Thus, we can argue that one aspect of the Dandelion preparation is to promote the plant symbiotic interaction with these fungi, thus expanding the plant's radius to the nearest meadow and small forest.

Spiritual forces and natural science

Today, there is ample scientific documentation that shows that the biodynamic preparations can have significant effects on plant growth, from seed germination and all the way to the ripening process. So, the question is not whether the preparations have measurable effects, but how we can come closer to understanding their working dynamics. Clearly, our understanding of how the preparations work is still insufficient. Not surprisingly, among biodynamic farmers there are differences in the way that the preparations are understood, produced, and applied.

Over the last decades, biodynamic research has become more professional with numerous research articles being published in international scientific journals. [14] Still, some natural scientific researchers describe biodynamic agriculture as based on pseudoscience, with no role to play in the ongoing development of sustainable agriculture [15]. The phenomena of spiritual forces and clairvoyant observation represent major stumbling blocks, so in the eyes of most natural scientific researchers, the preparations are highly controversial, despite their documented effects on plant growth.

In 2015, a review of the existing literature on 'remote healing' was conducted, here meaning that energy is transferred from the healer to the recipient organism, resulting in a measurable, positive health effect. After discarding several studies which did not meet the strict methodological criteria, roughly 50 studies remained in which a trained or untrained healer had 'healed' cell cultures or experimental animals. [16] In an experiment with sea urchins, the healing took place with the healer's hands approximately 10 cm from the animals. During the experiment, the immune cell activity of the animals was also measured. The results showed that the wound healing and immune activity were significantly higher in the group of sea urchins which were healed. To explain the phenomenon the researchers used the terms 'bioelectromagnetic field' and bioelectromagnetic energy'. The healer's bioelectromagnetic field had affected the corresponding field of the animals, including their immune system. [17]

In my personal experience, meeting clairvoyant people is the most helpful way to form a qualified opinion of this human ability. Personally, I have met five clairvoyants. Three of them describe themselves as having only minor clairvoyant abilities. One person developed his abilities as an adult and works

today as a spiritual therapist. Another person also developed clairvoyant abilities as an adult, and today he is active in biodynamic research in Germany. He has described in detail the process of developing clairvoyant abilities, based on meditations and exercises recommended by Steiner. Furthermore, he is actively helping different groups working to develop and apply clairvoyant abilities.

We will return to this question in chapter 4.

The fruit formation

All plants go through recognisable phases during their life cycle; the seed germinates, the leaves and stems unfold and turn towards the light, the flower buds open, and finally it all ends with new seeds. Our agricultural crops - wheat, carrots, potatoes, cabbage etc. - also go through a ripening phase. The wheat kernels swell, the straw and the leaves slowly wither, and when the kernels are ripe, the whole plant is yellow with a minimum of activity in the kernels. In the first part of the season, the leaves of the carrot grow and gradually the whole field is covered with green leaves, while the thin roots swell below the ground. When the roots are ripe, they are no longer pointed, but rounded and ready for the winter. The carrot has a two-year cycle so if we leave a carrot in the soil, next spring a flower stem will come forth from the root with seeds for the next generation.

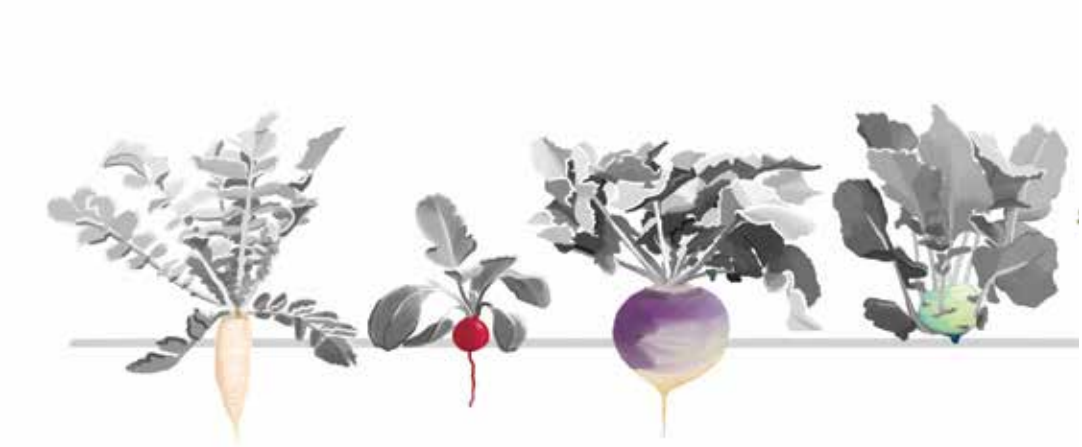

Figure 2. *Illustration of members of the Brassica family, with fruit formation from the root (turnips, radish) to the flower (cauliflower).*

Steiner stated that the task of spiritual science relative to agriculture is to offer the means of treating the manure in such a way that the soil will be enlivened, so that the plant can grow in a living soil and reach its fruit formation. We are familiar with the fruit formation in apples and pears, but Steiner used the term in a broader sense. Our agricultural crops, such as wheat, cabbage, carrots, potatoes, onions etc., also show a fruit formation; however, this can take place further 'down' in the plant development. Here, the root, the stem, the leaves, or the flower will swell with fruit tissue.

Let us go back in time to the early stages of agriculture. Wild buffaloes and boars were domesticated into our present day cows and pigs, and in parallel to this, wild grasses were transformed into the ancestors of our modern grains. The ancient Persian wheat from the Mesopotamian delta originated from a wild grass, just as today's cabbages originate from wild cabbages. When we compare modern carrots from the supermarket with wild carrots in nature, we can see that modern carrots have developed a 'fruit root'.

Indeed, a fruit formation can take place in all organs of the plant. In the onion, the fruit formation takes place in the lower part of the stem which we eat. In the case of broccoli, the fruit process takes place at the flowering stage, and in wheat it takes place in parallel to the seed formation. Botanically speaking, the seed formation can only take place in the ovary where the seeds are nurtured from the bottom of the flower whereas fruit formation can be found in all or-

gans of the plant. When we compare different crops from the Brassica family such as radish, white cabbage, and broccoli, we find that the radish is a root fruit, the white cabbage is a stem/leaf fruit, while the broccoli is a flower fruit, see Figure 2.

Steiner described the fruit formation process based on clairvoyant observation. The plant has two 'bodies', the physical and the etheric, but during the flowering and fruit formation processes, astral forces are active from the 'outside'. However, this process cannot take place in the right way in a large, open field, such as those we often see today. The crop will suffer from a deficiency of astral forces because these are not sufficiently present and active. They can only be active in a landscape in which you find a critical number of perennial trees, and if these are not sufficiently represented, a 'crippling' of the crop will take place, due to the lack of astral forces. The result is that the flowering process and the fruit formation does not take place in an optimal manner.

The vine – a master of ripening

Let us take a unique example of fruit formation and ripening: the vine. This plant prefers a warm and sunny climate, the soil must not be moist, and irrigation should be avoided since this will weaken the flavours of the wine. The plant should preferably starve and thirst a little in order to intensify aroma and taste. To achieve this, many of the leaves and bunches should be cut away in the spring, to ensure that the remaining ones have sufficient light. At harvest the grapes need to be fully ripe and should be hand-picked and sorted. All grapes with mould must be removed. Then, a long process starts in the wine cellar. The taste of the fresh grapes will slowly withdraw, and the numerous flavours of the wine will come about.

This ancient way of making wine is stubbornly maintained by a small group of the world's best wine growers. In contrast to this, conventional wine production has over the last 50 years been completely transformed. Mineral NPK fertilisers have replaced the composted animal manures, industrially produced yeast cultures have replaced the microorganisms which naturally live on the grapes, and several enzymes, colours, flavours and additives are allowed in the wine cellar. The result is that the numerous fragrances and flavours of the wine have been severely reduced.

The many secondary compounds of a unique wine, which can be found in smaller concentrations in berries and other fruits, are reduced in the conventionally made wines. It is well known that red wine in moderate amounts has positive effects on cardiovascular disease, diabetes, cancer, and other diseases.

In 2006, a long-term field trial called INBIODYN was established at the University of Geisenheim in Rheingau, Germany which specialises in viticulture. The goal of the trial is to investigate the effects of conventional/integrated, organic, and biodynamic cultivation as well as the wine quality. The grape yield was 20-25% lower in the organic and biodynamic plots, as compared to the conventional/integrated plots. Generally, the differences in the growth parameters between the organic and biodynamic plots were small. On the other hand, based on picture forming methods (see chapter 4), significant differences were found in favour of the biodynamic plots. Here, when evaluating the results from 10 years, the biodynamic samples were almost exclusively ranked better than the organic samples. A positive effect was also found from repeated use of the Horn Silica preparation. These results indicate an optimised ripening as result of the preparation treatments. [18,19]

The protein – the real body of the plant

Let us start by examining protein from a natural scientific point of view. Very simply put, we as humans need roughly 0.8g protein per kilo body weight for 'maintenance'. Consequently, a person weighing 70 kilos will need around 55-60g protein per day. When we work hard and if we are building up muscles we need more. These proteins must contain sufficient essential amino acids which our body cannot produce itself. Biochemists can show us numerous types of proteins, with different forms, sizes, and functions. In plant, animal and human cells, we find thousands of proteins, each with a unique function. The biochemist will say that a cell is what it is because of the kinds of proteins it contains.

Since the 1950s it was believed that 'one gene carries the code for one protein which regulates one life process'. Today we know that things are somewhat more complex. Concerning the protein structure, each protein is built from 20 different amino acids, the total number of which ranges from a few hundred to millions. During the formation of a protein, each amino acid is connected to a growing chain of them which then make up its primary structure. These chains are then wound and/or folded in different ways, making up 3-dimensional spherical structures, plates or spirals which constitute the secondary structure. Finally, these units are combined into overall structures which are held together by numerous sulphur bridges. The protein is ready to go to work.

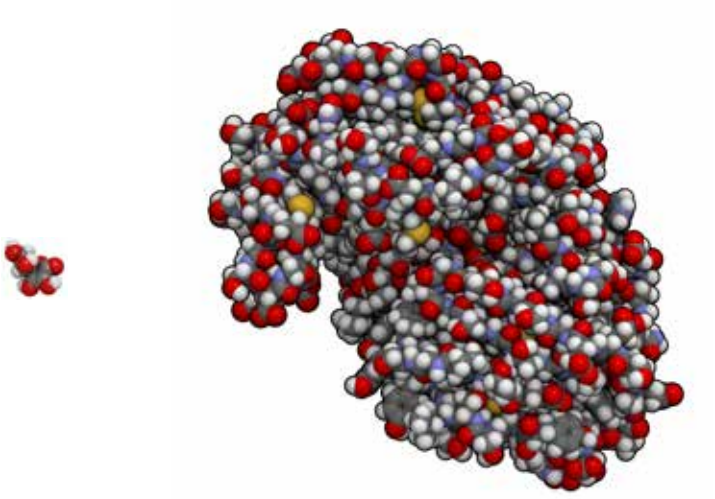

Figure 3: *An illustration of the molecular size of a vitamin C versus that of a small enzyme.*

Biochemists speak of seven groups of proteins in the human body:

(1) ***Structural proteins*** *which give the cells their shape.*
(2) ***Transport proteins*** *such as haemoglobin which carry oxygen in the blood.*
(3) ***Muscle proteins*** *which make it possible for animals and humans to move.*
(4) ***Signalling hormone*** *proteins which regulate many physiological processes and coordinate the activity of different organs and tissues.*
(5) ***Storage proteins*** *which are analogous to those found in plant seeds, serving as basis for the germinating seed.*
(6) ***Immune system proteins*** *which play an important role in protecting the body from harmful foreign substances and microorganisms, and finally:*
(7) *Enzymes which perform countless* ***biochemical reactions****, such as the digestive enzymes in the mouth, stomach and intestines.*

Proteins can also be grouped according to their activity level or the number of hours/days/minutes before they are worn out and replaced by new ones. Muscle proteins may last more than 100 days, and structural proteins more than 150 days, whereas enzymes last for only hours and minutes. The enzymatic activity is reflected in the number of turnovers per second, meaning the number of times the enzyme can perform a specific activity. Here, the enzyme called carbon anhydrase manages 600,000 turnovers per second! The activity of proteins and enzymes is strongly influenced by changes in temperature and pH, as well as the presence or absence of certain minerals and chemicals, serving as catalysts speeding up the processes. Non-optimal conditions may result in a deformation of the 3-dimensional structure of the enzyme, whereby its functionality is blocked: the enzyme has been 'denatured' and can no longer work.

Proteins as seen from a spiritual scientific perspective

The third lecture of the Agriculture Course is devoted to proteins, mainly seen from the point of view of manuring. Later, the protein is called 'the real body of the plant'. Here, we should note that the spiritual forces of nature can only be active in the presence of specific physical elements and substances. The etheric forces can only be active in the presence of oxygen, through nature's countless oxygen compounds, and the astral forces can only be active in the presence of nitrogen.

Furthermore, a carbon structure is a prerequisite for a living organism, be it a plant, an animal or a human. The 'spiritual image', the 'blueprint' of the organism can 'incarnate' into these carbon structures. Here, nitrogen is the bridge-builder between the 'spiritual image' and the life processes. 'The nitrogen leads life into the form embodied by the carbon. Wherever the nitrogen occurs, it has the task of being the mediator between the living and the spiritual, which has initially been shaped in the carbon. The bridge between oxygen and carbon is built everywhere in the animal and plant kingdom, and, also in the interior of the Earth, by the nitrogen'. Finally, sulphur is active when a spiritual activity starts to take place, and hydrogen is needed when a spiritual activity stops, and the forces return back to the surroundings and to the cosmos.

Proteins hold a key position in living organisms. Protein must be present right from the beginning. Protein is what really forms the human being, what develops it. It is the original, the basics. 'Protein is the substance in the living body that can be transformed by its formative forces in the most diverse ways, so that what emerges from the transformed protein substance appears in the forms of organs and of the whole organism .... These formative forces are bound to the etheric body. The protein is constantly on the move, either to be absorbed in the activity of the etheric body, or to fall out of it. Protein which has fallen out of the organism to which it belongs tends to be a compound which is subordinate to the inorganic forces of hydrogen, oxygen, nitrogen, and carbon. Protein, which remains part of the living organism, suppresses this tendency and inserts itself into the essential forces of the etheric body'. [20]

We see that what Steiner called proteins correspond not least to enzymes, the craftsmen of the cells managing the countless life processes. Biochemists first isolated enzymes at the beginning of the 1920s, however, their crucial role was not understood until much later. In the Agriculture Course enzymes are not mentioned. However, in the last of Steiner's books, and in his late lectures, the role of enzymes in our digestion is presented. Here, already in the mouth the enzyme ptyalin starts to break down the food, and when we have chewed and swallowed the food, the enzyme pepsin will continue the work in our sour stomach. Finally, in the intestines the enzyme trypsin from the pancreas will be active in neutralising the foreign etheric and astral forces in the food. In these enzymes both the etheric body, the astral body and the I are at work. In a given enzyme the etheric body may be especially active, whereas the astral forces and the unconscious I forces may be more in the background. Through

the proteins and enzymes etheric forces regulate the countless life processes of plants, animals, and humans. In chapter 5 we shall take a closer look at the specific role of fruit proteins in building new proteins and enzymes, and in building and activating our limbs and digestive system.

The agricultural individuality

Since the Second World War, conventional agriculture has gradually adopted an industrial approach to farming. In contrast to this, in organic agriculture the farm is seen as an integrated part of the surrounding landscape and ecosystems. The concept of a 'farm organism', a balanced micro-ecosystem, is essential in organic farming.

In biodynamic agriculture, the farm is also seen as an organism, based on a balance between the soil, the crops, the animal husbandry, and the surrounding nature. In addition to this, Rudolf Steiner introduced the concept of an 'agricultural individuality': 'A farm is true to its essential nature, in the best sense of the word, if it is conceived as a kind of individual entity in itself – a self-contained individuality. This ideal cannot be absolutely attained, but it should be observed as far as possible. Whatever you need for agricultural production, you should try to possess it within the farm itself, including on the farm, needless to say, the due amount of cattle.' [21]

Clearly, this point was highly important to Steiner since he otherwise used the term 'individuality' in connection with humans. As human beings we can work on our 'lower' bodies, on the physical, etheric, and astral body. An experienced teacher will know in which way the students' curriculum will stimulate the emotional

and mental development of the students. An experienced clairvoyant therapist can observe abnormalities in a patient's etheric and astral bodies, and he/she will be able to influence these in a beneficial way. Similarly, the experienced biodynamic farmer can build an agricultural individuality, based on a balanced crop rotation, a balanced animal husbandry, and a balance between the cultivated land and, on the other hand, the hedges, biotopes, and forest areas. By means of the biodynamic preparations, the farmer can also shape the farm towards an agricultural individuality. Hereby, the farmer will influence positively the nutritional value of the vegetables, fruits, grains, and milk from the farm.

But how can the farmer work with the I forces of this individuality? Clearly, the farmer represents a human I on the farm, and as such he/she is responsible for orchestrating all the elements of the farm. However, in the Agriculture Course, Steiner mentioned that I forces can also be found in the cows' manure. The background for this is that herd animals such as cows do not have an individualised I, such as the human being does. Instead, they share a common herd I, a spiritual group soul which is not incarnated into the individual member of the herd. Hereby, a part of the herd I force is present in the manure as a 'nascent I force', in the process of becoming. When the compost is spread on the soil, these forces are also taken up by the plants, and ultimately, these forces will exercise a subtle effect on those eating the plants. The task of the farmer is to provide highly nutritional foods to humans of body, soul, and spirit. Through promoting the fruit formation of the crops as well as the different balances on the farm, the health of the agricultural individuality will be promoted, based on a balanced activity of its four 'bodies'.

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The many faces of plant quality

3

In this chapter, the main factors which influence the quality of vegetables, fruit, and grains are presented. The nutritional quality of a batch of carrots may be evaluated as optimal by a chemist, based on the content of vitamin A and antioxidants. The same batch may be evaluated as highly tasty by a sensory panel, and it may be evaluated as highly suited for juicing by a fruit processing company. We will here focus primarily on the nutritional quality.

The wondrous world of plants

In nature's large household, plants are the primary producers, the first step in countless food chains. Hares and antelope are herbivores that eat plants, and wolves and lions are carnivores that eat these herbivores. The old saying 'The plant gives, the animal takes' summarises this fundamental fact. Without plants there would be no animals, no green landscapes, no jungles, no grain fields, no daily bread. At first sight, plants may seem defenceless in every way, including against attacks from insects, but this is not necessarily the case. When an insect starts to eat from the leaves of certain trees, the leaves will immediately start to produce specific chemical compounds with a flavour that repels the insects, so that they fly on. And what is more, shortly after an insect has taken the first bite of a particular tree, the leaves of the neighbouring trees will start producing these compounds. The trees warn each other by means of volatile compounds excreted from the leaf surface.

Nature never ceases to surprise and amaze us, since our expectations mostly

reflect what we as humans can sense and tolerate. Seventy years ago marine scientists did not expect to find living organisms at the bottom of the deepest seas, since the atmospheric pressure at these depths is more than 1,000 times higher than that of the Earth's surface. Later, an unmanned submersible with cameras was lowered to the bottom of the Mariana Trench, at a depth of 11 kilometres, documenting that the oceans are full of life even at these depths. In 2012, the first researcher made it to the bottom of the Mariana Trench in a submersible.

We may indeed expect that the plant kingdom will surprise and amaze us. And it does. A few years ago, it was discovered that plants may have an amazing ability to camouflage themselves. It is well-known that some coral fish change their colours according to the rocks and plants they swim amongst, and that some fish can imitate the colours of the seabed. It was discovered that a clinging plant in Chile can change both the shape, colour, and size of its leaves according to the trees on which it climbs. It can even imitate the leaf ribs of the leaves of the host tree! Researchers have no explanation for this whatsoever. [1]

Plants are neither deaf nor blind, and they sense and actively communicate with their surroundings. They excrete a range of compounds which can both help and harm their fellow plants. The Corncockle plant can excrete compounds which will stimulate the growth and even the protein quality of wheat, and some agricultural plants can excrete compounds which will inhibit the growth of surrounding weeds. Furthermore, recent discoveries have shown that plants and trees communicate via sounds. Maize roots can register low-frequency sounds around 200 Hertz and will answer back with sounds around 220 Hertz, and some trees send out sounds resembling musical chords. This new research field of bioacoustics indicates that plant roots act as a brain, with the 'command centre' located at the root tip. This brain continuously registers the surroundings and can respond to a spectrum of signals. The only sure thing is that new discoveries will follow in the coming years, for the simple reason that measuring instruments are constantly being improved. [2]

In aquaponic production systems, a tomato plant will typically grow in a bucket with mineral wool connected to a tube which supplies a continuous stream of water and nutrients. The perception of a plant in this production system is that whatever plants need can be supplied based on industrial inputs. But a plant is deeply connected to the surrounding ecosystems. In the 1950s, it was discovered that plants and fungi have been cooperating for millions of years. The so-called mycorrhiza fungi supply plants with nutrients and water, and in return they get sugars. These are crucial to the fungi, since they have no photosynthesis, and for the plants, the nutrients are necessary since some minerals are so tightly bound in the soil that their roots cannot access them. This plant-fungi cooperation is called symbiosis. On one hand, the fungal mycelium below the ground is connected to the plant roots, and on the other, the mycelium is exploring a wide radius in the soil, absorbing phosphorous and other minerals after secreting acids and enzymes into the soil.

Some trees are connected to as many as 15 different types of mycorrhiza, and most pines and conifers can only survive for a few years without specific fungi. Up to 85 percent of all plant families live in symbiosis with mycorrhiza, and this also applies to our agricultural crops. Further, pines and birch trees exchange nutrients via mycorrhiza, and trees growing in shade may receive nutrients from neighbouring trees standing in the light. These discoveries have changed our simplified view of 'survival of the fittest' in nature. [3]

Finally, we should note that plants take up nutrients from the air, literally absorbing minerals and nutrients which are present in the atmosphere in homeopathic concentrations. A striking example of this is the Tillandsia plant, which we find not least in the forests, mountains, and deserts of northern Mexico. These plants are also called airplants, because of their ability to cling to whatever is available, including bare rocks and even telephone wires. When living on trees, they have no roots entering the host tissue, and as such they are not parasitic organisms. Their leaves are covered with so-called trichome cells which rapidly absorb even minute concentrations of humidity from the air. Based on analyses of the mineral content of Tillandsia plants living on telephone lines, it was documented that these plants can absorb a large spectrum of minerals from the air.

The plant between light and shadow

Every day, nature supplies the farmer with a raw material which is crucial for the crops to grow. We are talking of sunlight. Throughout the whole life cycle of germination, growth, flowering, and seed/fruit formation, plants react strongly to light. Some flowers follow the arc of the sun during the day, and when walking in a forest we can see how plants and trees fight to win the race towards the light, to be able to perform their photosynthesis. This is a continuous creation of organic matter, of 'life'.

No biochemist can imitate this highly advanced handling of the light implementing without time and energy consuming processes in the laboratory. By means of sunlight plants combine the air's carbon dioxide and water into a simple sugar. This glucose flows from the leaves to every cell of the plant, serving as the basis for producing countless compounds, including sugars, fats, proteins, vitamins, hormones, antioxidants, flavours, etc.

In the forest, we can see that the size of the leaves is larger on plants growing in shade, and, also, that these leaves are more rounded. We can notice that the plants growing in full daylight bring forth more flowers, and that they display a different spatial expansion. Plants growing in shadow will have a more horizontal, hanging gesture, whereas plants growing in daylight will have a more vertical gesture, with leaves having an upward stretching gesture. From everyday life, we know that apples will turn red or yellow in the sun. In parallel to

this, the content of vitamin C will increase, as a common characteristic of fruit. You might even say with a smile that vitamin C is canned sunlight. Apples growing in full daylight will contain considerably more vitamin C than those growing in half-shade. Similarly, more glucose from the photosynthesis will be converted into sucrose, whereby the apples will be sweeter. Chemists can examine the activity of several enzymes, reflecting if the plant metabolism is still active at harvest, or if the plant has ripened, whereby the enzyme activity will drop markedly. Finally, a broad spectrum of flavours will develop in apples, according to the individual variety. Figure 1 below lists nine characteristics of plants growing in full daylight, as compared to those growing in half-shadow.

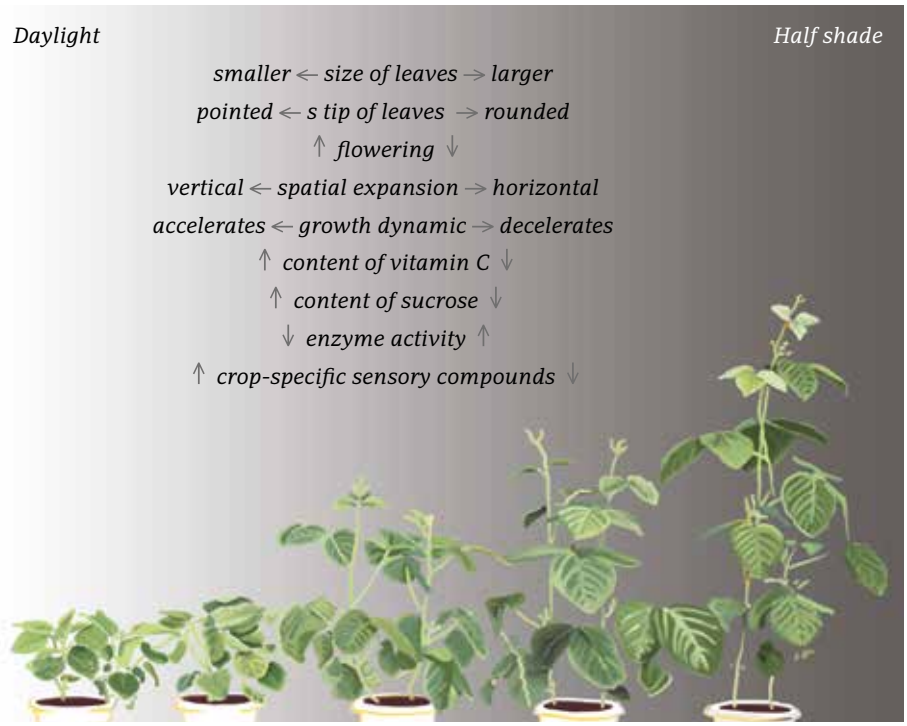


Figure 1. *Nine characteristics of plants growing in daylight and half shade.*

As a boy of 12, I was in a group of boys who found great joy in stealing apples during the summer and autumn months. We knew nothing about sensory compounds, but we knew which apples to steal and which to leave on the trees. We knew that apples facing north would stay green until late, while the apples facing south would grow sweet and juicy. We knew which apple varieties were worth the risk of getting a slap on the face, together with a harsh scolding from

the owner of the tree. When we went on a mission, we would look out for the owner and for passers-by: some boys would climb to the top of the trees, whilst others would stand below and catch the apples. Our pockets would be filled and then we would discreetly leave the garden with our bounty. In a nearby quiet spot, the apples were placed on the ground, and the oldest boy would divide the best apples among the group, until everyone nodded. Then, the rest were freely available, and whatever was left was thrown into the nearest garden. In scientific terms, we had performed an experience-based identification of firm, coloured apples, rich in high-molecular sugars and crop-specific sensory compounds!

These effects of light and shadow represent a first key in understanding the nutritional quality of our agricultural and horticultural crops. Based on this approach, conventional crops can in most cases be differentiated from organic and biodynamic crops. And, when comparing different soil types, we find that sandy soils increase the daylight characteristics of the crop, whereas a heavy clay soil will pull towards the half-shade characteristics, while an average humus soil will have an intermediate position. Further, we find that when increasing the amount of compost, a plant will be pulled towards the daylight characteristics. Last, but not least, when applying the biodynamic Horn Silica preparation, plants mostly react as if they have been exposed to more light. Hereby, the fruit formation and ripening is promoted. [4]

These results were encouraging to biodynamic researchers and farmers. They documented measurable beneficial effects of the biodynamic cultivation measures, including composting and biodynamic preparations. Further, the results documented that the biodynamic measures indeed promoted fruit formation, be it root fruits such as carrots or real fruits such as apples. Finally, these results could easily be communicated to consumers, farmers, and researchers, as well as decision makers.

Nitrogen and plant growth

Let us now look at the key role of nitrogen in plant growth and quality. We may say that nitrogen is just as indispensable from 'below', as sunlight from 'above'. The reason is that without nitrogen a plant cannot produce proteins and enzymes since nitrogen is an integrated part of their molecular structure. So,

without nitrogen the etheric body of the plant cannot work. Nonetheless, too little and too much is harmful. If a wheat crop has hardly any nitrogen at its disposal, the leaves will be small and light green, the straw short, the kernels tiny, and the harvest minimal. As the amount of available nitrogen increases, the wheat will have more side shoots, the straw will grow longer, and the kernels larger. When further increasing the amount beyond a moderate level, the nitrogen will become a stress factor, and the growth phase will be prolonged at the expense of the ripening process.

In conventional agriculture farmers have inorganic nitrogen fertilisers at their disposal, whereas organic and biodynamic farmers must rely on animal manures and leguminous crops such as clovers which collect nitrogen at their roots, in symbiosis with nitrogen-fixing bacteria. Nitrogen is continuously released from the humus layer during the growing season, depending on the amount of humus, the temperature, and the microbial activity. Unless organic and biodynamic farmers have unintentionally over-fertilised a field with fresh manure, the crop will not suffer from an excess of nitrogen. In contrast to this, conventional farmers may more easily over-fertilise a crop. In this case, at harvest the crop will contain an excess of nitrate, since the plant is still in active growth, with 'undigested' nitrogen in the plant sap. The nitrate content of organic and biodynamic crops is generally lower than that of conventional crops since the desired level of yield is higher in conventional agriculture than in organic and biodynamic agriculture.

Interestingly, the effects of increasing the nitrogen level beyond a moderate level are similar to the effects found when plants grow in half shade. Table 2 below shows the characteristics of plants that are exposed to nitrogen beyond a moderate level. Note here that the first four characteristics – content of vitamin C and sucrose, enzyme activity at harvest, and crop-specific sensory compounds – are also found in Table 1. This means that when increasing the amount of nitrogen beyond a moderate level, the reaction is similar to that of reducing the amount of light to a sub-optimal level.

In Figure 2 below, as compared to Figure 1, four new characteristics are added: dry matter content, nitrate content, ratio of raw protein/pure protein, and storage ability. The amount of dry matter – what is left when water is evaporated - will decrease when increasing the level of nitrogen. Thus, excess nitrogen stimulates the plant to take up more water.

Content of vitamin C ↓
Content of high-molecular sugars ↓
Enzyme activity at harvest ↑
Crop-specific sensory properties ↓
Dry matter content ↓
Nitrate content ↑
Ratio of raw protein/pure protein ↑
Storage ability ↓

Figure 2. *Eight characteristics of plants when increasing the level of inorganic nitrogen beyond a moderate level.*

At the same time, the amount of residual nitrate will increase, since the plant is unable to metabolise all the nitrogen into carbohydrates, fats, proteins, and other compounds. Nitrate is the small compound which plants take up from the soil. It is not healthy for humans, especially for smaller children who cannot yet produce the necessary enzymes to break it down. The increase in the ratio of raw and pure protein reflects that many small nitrogen containing compounds have not yet been fully transformed into proteins. This indicates a less ripe crop with sub-optimal fruit formation. Generally, in conventional crops this ratio will be higher than in organic and biodynamic crops due to the higher level of nitrogen applied. Finally, we find a higher number of essential amino acids in organic and biodynamic plants than in conventional ones.

But does it really matter for the plant that some nitrates and amino acids are floating around in the plant sap? The answer is yes. The level of inorganic nitrogen will affect the ability of for example a wheat crop to resist a fungal attack. Fungal spores are everywhere in the air during a prolonged wet period. Let us look at an experiment in which wheat was grown in field plots and fertilised with different amounts of inorganic nitrogen. Over two months, the percentage of leaves which were attacked by mildew spores was counted every second week, see Figure 3 below.

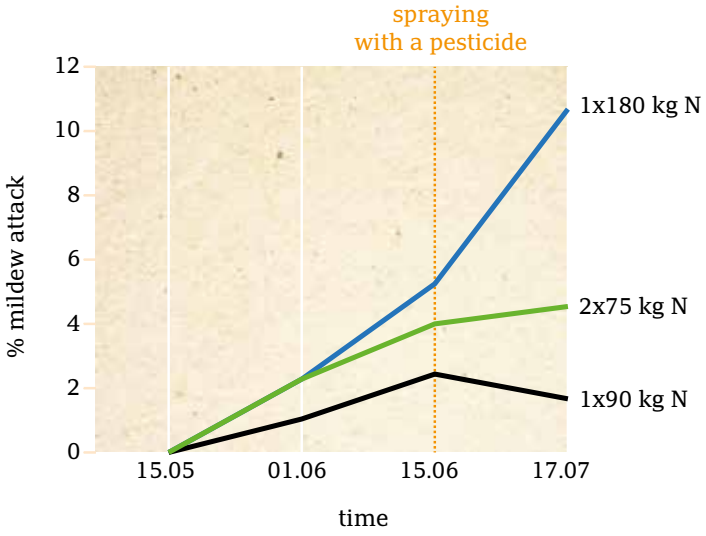


Figure 3. *The level of mildew attack in a wheat crop, as measured at four time-points during the growing season from mid-May to mid-July (horizontal axis). The level of attack is measured as the percentage of affected leaves (the vertical axis) after fertilising the crop with three different nitrogen levels. When fertilised with 90 kg N per hectare, the crop is able to minimise the fungal attack; with 2x75 kg N the crop can stabilise the attack, while with 180 kg N per hectare the attack develops exponentially, thereby making repeated application of pesticide necessary.* [5]

The horizontal axis shows four days from mid-May to mid-July on which the level of fungal attack was measured, whereas the vertical axis shows the percentage of leaves which were attacked. The bottom black curve shows the level of fungal attack when the wheat was given a low amount of nitrogen (90 kg per hectare). Here, approximately two percent of the leaves were attacked in mid-June, but after spraying with a pesticide the crop was able to stabilise the attack, and the curve was broken. If the farmer had not used a pesticide against the fungi, the attack would have developed further. In any case, a nitrogen level of 90 kg for wheat results in a low yield which no conventional farmer will accept.

The upper blue curve shows the development when the crop was given double the amount of nitrogen (180 kg per hectare). At this amount, the crop could not stabilise the fungal attack. By mid-July, roughly 11 percent of the leaves were

attacked. If the farmer had not used a pesticide, the attack would have continued uncontrollably, and the yield would have been minimal. Finally, the middle green curve illustrates the use of 150 kg of nitrogen per hectare, distributed as two separate portions of 75 kg with some weeks in between. Here, the wheat crop could nearly stabilise the attack, provided that pesticides were used. [5]

This simple experiment shows that a conventional wheat crop will lose its ability to withstand a fungal attack when fertilised with a 'normal' amount of inorganic nitrogen (180 kg per hectare). However, this level corresponds to what is often used in conventional agriculture in Central Europe. The crop will enter a state of minor stress, and its ability to resist the microbial attack decreases. Thus, the use of inorganic nitrogen fertilisers and fungicides are two sides of the same coin. The nitrogen represents the accelerant which will provide the desired yield, whereas the fungicide represents the brake which will remove the fungal attack, as an undesired side effect of the conventional cultivation system.

When we drive around the countryside on a late summer day, we may enjoy the sight of yellow grain fields. But we may easily forget that, in the case of conventional fields, the farmers have used fungicides during wet periods. Without these, the fields would be speckled with red, brown, and black colours from fungal attacks. Without the use of fungicides, the harvest would be lost in a wet season. As opposed to this, in organic and biodynamic fields the level of compost and animal manure used will generate a lower yield, however in most cases the plants can resist fungal attacks and perform their normal life cycle.

The combination of high-yielding modern wheat varieties and a systematic use of pesticides against weeds and fungi was introduced during the so-called Green Revolution. In 1970, these wheat varieties covered about 20 percent of the wheat area around the world, and roughly 30 percent of the rice area in developing countries. By 1990, these percentages had increased to roughly 70 percent – indeed a revolution! But a major price was paid: the crop had lost its ability to resist fungal attacks. When it comes to human nutrition, the question is whether there is a connection between this ability to resist microbial attack, and on the other hand, the ability to support our health.

Surprisingly, as soon as a tiny fungal spore lands on a leaf and starts drilling its way into the leaf, the wheat plant registers the attack. It swiftly responds by

producing a high concentration of specific secondary compounds just around the attacking point. This concentration is so high that a microscopic circle of tissue around the spore will die. Thereby, the spore cannot develop its mycelium inside the leaf, and it dies. If the wheat is not stressed due to too much nitrogen, it can mobilise the necessary defence compounds, thereby enacting countless 'suicides' on its leaves. It is crucial for the wheat that its photosynthesis can continue.

Primary and secondary compounds

The food products in a supermarket carry nutritional labels with information about the content of minerals, carbohydrates, proteins, fats, fibres, and vitamins. Our health is dependent on a stable supply of these nutrients. Vitamins and trace-minerals are micro-nutrients that we need only in small amounts every day, whereas the rest are macro-nutrients which we need in larger amounts. But in addition to these compounds, biochemists have identified and grouped thousands of so-called secondary compounds in plants. These are the ones that give the volatile smells of coffee, the sharp taste of garlic, the delicate flavours of wines, the tantalising tastes of spices, the colours of flowers, and the compounds mobilised by plants when attacked by insects.

Metaphorically speaking, the primary compounds – minerals, carbohydrates, proteins, and fats - represent the visible top of the iceberg, while the secondary compounds represent the remaining 90 percent below the surface. Several of these compounds can influence our health, with potent effects on diseases such as cancer and diabetes. Here, a race is underway among pharmaceutical and medical companies in their search for wild plants with medicinal properties in jungles and rainforests.

Figure 4 below shows some specific secondary compounds with known positive health effects on humans. Today, numerous scientific article have been published on the connection between the different groups of plant secondary compounds and human health. [6].

When speaking of secondary compounds, we should be aware of the phenomenon of synergy, or in other words a cocktail effect. Specific compounds affect each other by increasing or decreasing their medical or toxic effect. Thus, Echi-

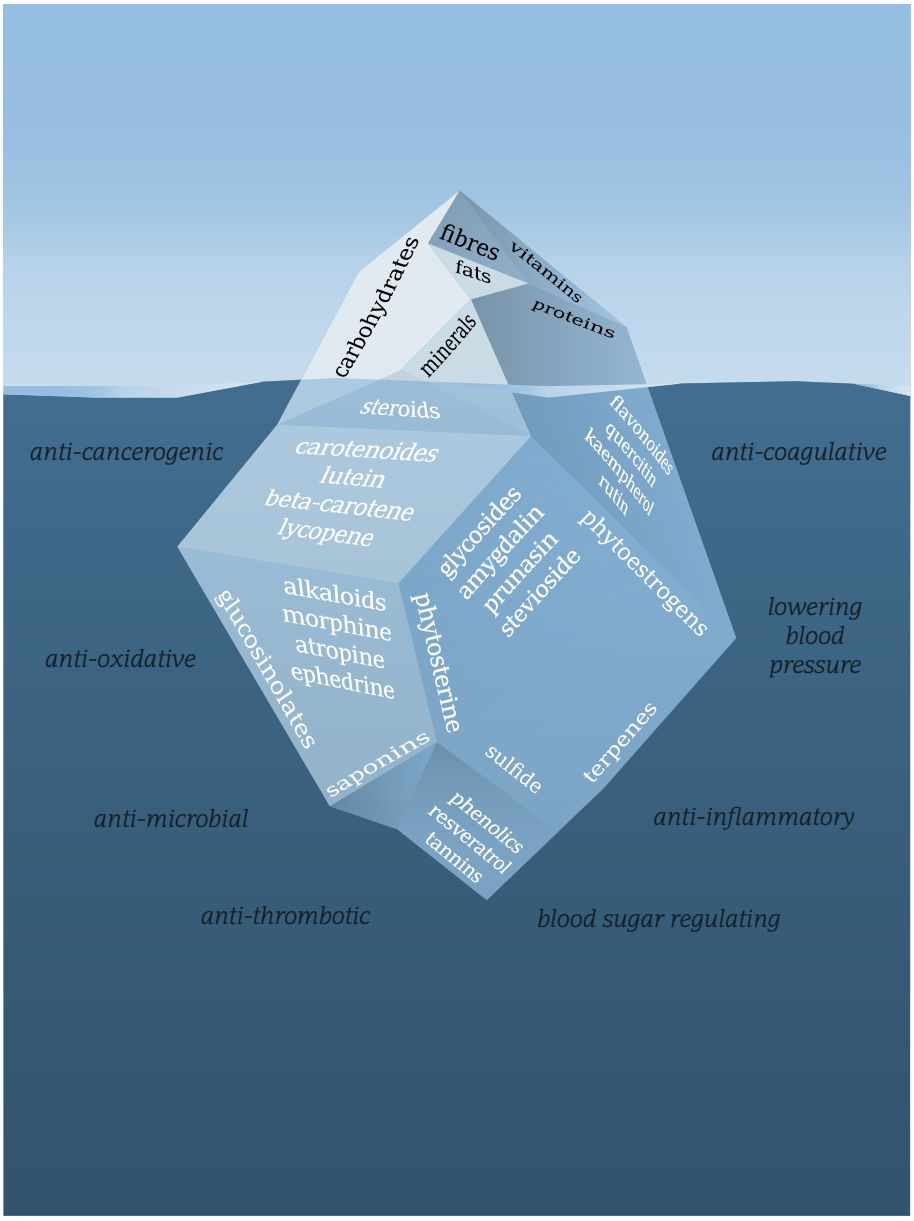


Figure 4. *Illustration of the proportion between primary nutrients with well-known effects on human health - the top of the iceberg above the water surface - and seconday compounds with more or less well documented anti-oxidative, anti-microbial, anti-thrombotic, anti-inflammatory etc. effects - the vast majority of the iceberg below the water surface.* [6]

nacea Purpurea contains several essential oils and so-called alkaloids which in combination are far more effective against colds and flu than a few isolated alkaloids. In the same manner, unpredictable positive or negative side-effects from medicine can be caused by two or more compounds interacting.

During the last few decades, medical researchers have worked with a more 'compound-holistic' approach to cancer treatment. Several combinations of secondary compounds have been tested, and a 'super-cocktail' of six compounds has been found which kills 100 percent of breast cancer cells in a cell culture. All six compounds are antioxidants, including four compounds which are found in common vegetables such as cabbage and celery, and in addition curcumin from the spice turmeric, and resveratrol from red grapes. We see again that the whole is more than the parts. The six individual compounds are not highly effective when applied individually, but as a cocktail, they give a stunning effect, presumably by combining effects targeting different aspects of the cancer cell division. Furthermore, no harmful effects were found when this cocktail was applied to healthy cells. [7]

Among the secondary compounds we especially find three groups which are known to influence our health: glycosides, phenolics, and alkaloids. These are all antioxidants, along with the well-known vitamins E and C. Antioxidants can neutralise harmful oxidation processes which take place non-stop in our cells. Here, the bitter substances of almonds are glycosides. In broccoli these are known to slow down the progression of cancer, and in the Digitalis plant we find glycosides which for centuries have helped to regulate an irregular heart rhythm. Even today, the medical preparations used for this regulation are based on specific glycosides from the Digitalis plant.
The second group, phenolics, are found all over the plant kingdom, in our vegetables, fruit, and spices. The entire grape vine contains numerous phenolics, including some used for defending itself against fungal attacks. The grape skin contains numerous bitter phenolics which we also find in wine, while others create the numerous flavours and aromas of wine.
The third group, alkaloids, contain compounds such as quinine, cocaine and strychnine, all compounds which have strong effects on our nervous system, even deadly effects. In the opium poppy biochemists have identified more than 25 alkaloids, the best-known being morphine, an addictive drug as well as an effective painkiller. In the Belladonna plant we find the poisonous solanine, which is also found in green potatoes that have been exposed to daylight.

Alkaloids are generally found only in minute concentrations, relative to the weight of the plant, and they are not beneficial to humans. The whole Nightshade plant family, including tomato, potato, eggplant, and pepper contain alkaloid compounds. Steiner pointed out that the members of the Nightshade family represent a burden to our digestion. All alkaloids are associated with a high concentration of astral forces which are 'pushed' too far into the etheric life processes, thereby generating an unhealthy imbalance. These cannot be digested in a normal way, and instead the sub-conscious I-organisation must step in and excrete these compounds. When eating potatoes as a key part of a daily diet, this will represent a digestive burden demanding spiritual forces which are otherwise intended for mental processes. [8]

In the comparative wine trial INBIODYN presented earlier, during the first 10 years several sensory tests were performed. Distinct variations were found between the different years, but a clear trend was found in favour of the biodynamic wines. Generally, the sensory panel was able to distinguish the integrated/conventional wines from the organic and biodynamic ones, based on descriptive characteristics such as fruity, clean, full-bodied, and intense. In four out of eight ranking tests, the biodynamic wines were ranked as number one. These tests reflect flavours originating from a broad spectrum of secondary compounds.

The vitality of plants

The word vitality comes from the Latin *vita*, meaning 'life'. It is used in various contexts and meanings. In everyday life, when we see puppies and kittens playing, we are charmed by their bursting energy, their vitality. When evaluating the effects of a new medical treatment, a questionnaire for the patients may include a ranking of their 'general feeling of vitality' after the treatment. Furthermore, plant scientists speak of seed germination vitality, the ability of seeds to germinate under unfavourable conditions in the field. In contrast to this, seed germination percentage shows how many out of 100 seeds from a given batch will germinate when placed in moistened sand in a heating cabinet. [9] Finally, the term vitality is mentioned in the EU regulatory framework for organic food and agriculture, in connection with the goals of organic agriculture. [10]

In a biodynamic context, vitality represents an optimal state of health. This

implies that the 'bodies' of an organism are working in a harmonious way, individually and collectively, to a degree that the organism can perform its life processes and life cycle while exposed to severe pressure from the surroundings. Hereby, the term vitality is akin to the concept of 'resilience', which is used in medical science to describe the adaptability of humans to different sources of stress, including traumas and diseases. In 2011, BMJ – one of the world's most prestigious medical journals – published an article focusing on the need for a new definition of health. [11] The present WHO definition – "health is a state of complete physical, mental and social well-being and not just the absence of disease or infirmity"– is so broad that it will be hard to find anyone exemplifying the definition. The resilience approach to health concerns the ability of an individual to maintain a dynamic balance in body and mind during life's stresses and strains.

In short: plant vitality has an 'inner' and 'outer' aspect. The inner vitality is seen when the plant mobilises secondary compounds to combat a fungal attack, while the 'outer' vitality is seen when the plant can support human health and vitality.

Organically fed bacteria with increased vitality

Let us examine an experiment comparing the ability of conventional and organic vegetable juices to support a specific enzyme activity of Salmonella bacteria. This enzyme holds a key position in living organisms, since if the enzyme does not function well the organism will not survive for long. During the continuous cell division of living organisms, errors will inevitably occur in the DNA string of the new cells. It is estimated that an adult human may have 1 million such errors every day in the genes of their new cells. These errors must be repaired so that the life processes can run normally, based on unharmed DHA strings. Here, specific enzymes repair these errors non-stop, every second throughout life. In bacteria, animals, and humans, we find these repair enzymes, and they are strikingly similar in their molecular structure.

In the above-mentioned experiment, microbiologists tested the ability of Salmonella bacteria to survive an exposure to mutagens, i.e. chemical compounds which cause extensive damage to their DNA string. The experiment contained the following three steps:
(a) Salmonella bacteria were pipetted into 66 petri dishes with vegetable juic-

es. The juices were divided equally into two groups of 33 dishes with juice from conventionally and organically grown vegetables, respectively.

(b) The two groups of 33 dishes each contained juices from a total of 11 vegetables (carrot, cabbage, spinach, onion, ginseng, etc.), with three dishes per vegetable juice.

(c) Into the three dishes containing to each one of the 11 vegetables were pipetted three different mutagens separately. Hereby, a total of 33 comparisons could be performed (2 cultivation systems x 11 vegetables x 3 mutagens).

(d) After 72 hours the number of bacterial colonies in the dishes was counted.

This experiment exposed the bacteria to an extreme pressure which threatened their very survival. If the bacteria were unable to mobilise sufficient enzyme repair activity, they would not be able to continue their cell-division, and they would ultimately die without having multiplied, whereby no colonies would be visible after 72 hours. The results showed that in 25 out of the 33 combinations of vegetable juice/mutagen, no statistically significant difference was found between the conventional and organic juices. In the remaining eight cases, the organic vegetable juices showed significantly improved enzyme repair,

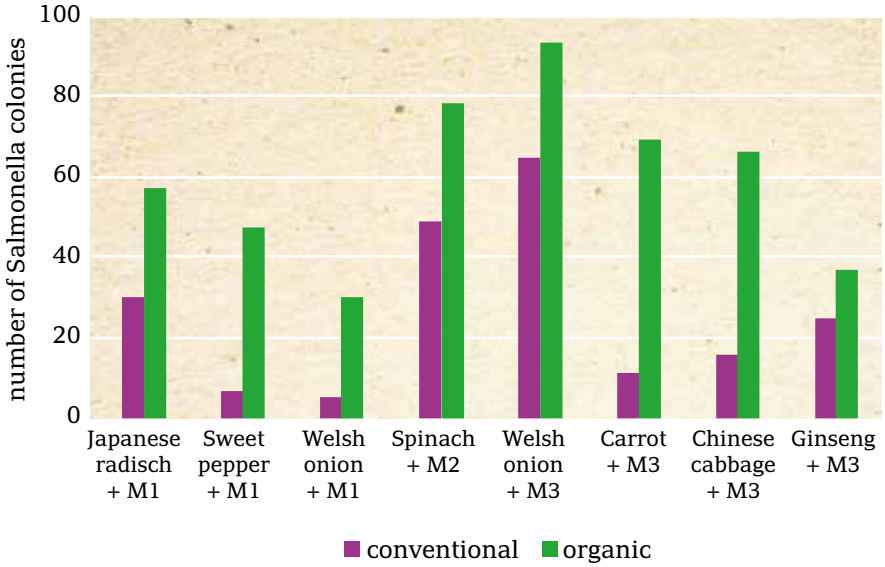


Figure 5. *Comparison of the ability of organic resp. conventional vegetable juices to mobilise DNA-repair enzyme activity (in %) in Salmonella bacteria. The higher the number, the higher the percentage of surviving bacteria in the original juice after exposure to one of three mutagens.* [12]

whereby more bacteria survived and formed new colonies. No case was found in which a conventional juice yielded more colonies than the corresponding organic one. [12] Figure 5 on page 79 shows the eight cases in which the organic juices showed a significantly better enzyme repair activity.

In parallel to the enzyme repair test, the antioxidant activity of the vegetable juices was measured. This activity expresses the total amount of compounds with antioxidant properties, including vitamins and secondary compounds. The results showed that the antioxidant activity of the organic vegetables was on average 50 percent higher than that of the conventional ones. [13] The vitality test was applied to bacteria however, since the DNA repair enzymes of bacteria and humans are very similar, the results indicate significantly better health promoting properties in organic vegetables, as compared to conventional ones. In addition, it is generally accepted that antioxidants are necessary for both bacteria and humans.

Biodynamic vitality tests

In biodynamic research, a spectrum of vitality tests have been developed and applied. A recurring characteristic of the tests is that vegetable, fruit, and grain samples are exposed to microbial attack after being sliced, grated, or juiced. The test may also include an increase in air temperature and humidity, whereby the activity of the microorganisms is accelerated. After a given period of time, the ability of the samples to resist microbial attack is measured. This is based on direct indicators of microbial activity, or indirectly measured via loss of sample weight, loss of dry matter, CO_2 emission, enzyme activity, and others. A large majority of the experiments have shown that organic and biodynamic samples perform better than the corresponding conventional ones; that when increasing the nitrogen level above a moderate level the microbial attack will be accelerated; and that the biodynamic preparations improve the samples' ability to resist microbial attack. [14]

Figure 6, on the opposite page, shows a typical set of results from an experiment with carrots which were grown at three levels of inorganic nitrogen, as well as at a fixed amount of cow manure, in combination with a stepwise increased application of the biodynamic field preparations (500; 501). The six indicators all reflect undesired effects indicating microbial activity. The arrows of the second column indicate that for all indicators low values are desired. For

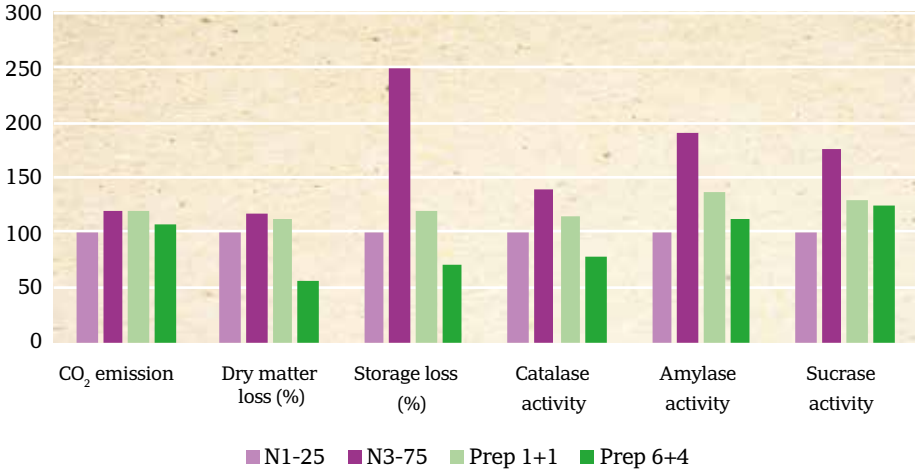


Figure 6. *Effects of three levels of inorganic nitrogen (25–75 kg per hectare), and of a fixed amount of deep litter cow manure, in combination with a four-step, increased application of the two biodynamic field preparations 500 and 501. The arrows in the second column indicate that low values are desired for all six indicators. For the column entitled 'Prep 1+1', both preparations were applied once, and for the column entiled 'Prep 6+4' the preparations were used six and four times, respectively.* [15]

experimental details, see [14, 15].

Note here that, as compared to wheat, the level of nitrogen per hectare for carrots is markedly lower (50–90kg per hectare), depending on the soil type and the available soil nitrogen. Here, an increase in inorganic N-fertiliser, from 25 to 50 to 75 kg per hectare, generated an undesired increase of indicator values since the vitality of the carrots decreased. In contrast to this, the four biodynamic preparation treatments (the four columns to the right), ranging from a single application of each of the field preparations ('Prep 1+1') to 6 x 500 and 4 x 501 ('Prep 6+4'), generated a desired stepwise decrease in indicator values. Here, the vitality of the carrots increased due to the stepwise more intensive use of the two preparations.

Cucumbers which grow together after slicing

Finally, let us look at a cucumber vitality test which I have personally worked with over the last few years, together with German and Polish colleagues. The cucumber samples should be up to 39 cm long, relatively straight, and with no

injuries from transport and handling. They are cut into 15+20 mm slices by means of a slicing apparatus, the slices are carefully re-assembled, wrapped in cling film, placed in a protective cylindric cardboard holder, and finally placed vertically in a heating cabinet at 24°C for 14 days. Then, the sample is evaluated based on the following three criteria: (a) degree of microbial attack, based on a visual scoring scale of 0–10; (b) degree of loss of the original green colour, based on a visual scale of 0–10; and (c) degree to which the slicing interfaces have grown together again, based on exposing specific interfaces to an increasing weight load. Figure 7 on the previous pages illustrates the three criteria, a sample being tested for slice-healing, and a sample hanging horizontally, having healed all slices after 14 days in a heating cabinet.

Thus, when testing a mixture of say 100 conventional, organic, and biodynamic samples, we can observe three main groups of samples after 14 days in the heating cabinet. In the 'yellow' group, the original green colour has changed into a mixture of greenish and yellow shades, yet showing only minor signs of microbial attack. This group will represent 60–70 percent of the samples. In the 'brown' group, the microbial attack is clearly visible on most of the slices, the colour is yellow and brownish, and in more severe cases the tissue of the sample is completely broken down into disintegrated, badly smelling lumps. This group typically represents 10–20 percent of the samples. Finally, in the 'green' group, the slices have maintained the original green colour, there are no signs of microbial attack, and all slice interfaces have grown together again to a degree whereby the 'cucumber' can hang horizontally without the slices breaking at any interface! Typically, this group represents 10–20 percent of the samples.

In all experiments carried out to date, the organic and especially the biodynamic cucumbers have performed better than the conventional ones. Note here that the conventional samples all originated from aquaponic productions, based on inorganic growth media, whereas the organic and biodynamic samples originated from organic growth media, with more or less focus on compost and a fertile soil. With regard to the slice healing, to our surprise we found organic and biodynamic samples which did not show signs of microbial attack until after 11 weeks. And we found samples which did not break until a weight load of nearly 7 kg was applied! A scientific article has been published on the first round of experiments. [16]
A future task will be to examine whether biodynamic samples perform better

Figure 7A: *Three cucumber vitality criteria : (1) 'Slice-healing Properties' (upper); here a sample with all slices healed; (2) 'Retainment of Green Colour' (second from top); here a sample with a partial loss of green colour towards yellow; (3) 'Anti-microbial Properties' (third from top); here a fully degraded sample. Further, a sample placed in a slicing apparatus before slicing (bottom).* ***Figure 7B****, on the following page shows a sample being tested for slice-healing properties by means of weights of 100g (upper), and a sample placed in horizontal position in metal holder, with all slices healed (lower).'*

Figure 7B

than organic samples. The results so far point in this direction. If this is indeed the case, this may be attributed to a combination of living soils, the use of compost and biodynamic preparations, and the use of open-pollinating cucumber varieties. A further task is to develop new tests which can be used for crops such as zucchini courgette, Chinese radish, and carrot.

The plant and the planets

Living organisms are rhythmic beings, spun into a network of rhythms. Some rhythms are triggered from outside by an external factor, others are triggered from inside by 'biological clocks'. Let us start with a cactus. Some cacti can survive for a few years without water. They simply close the tiny openings on their leaves and stems through which they breathe. Hereby, they preserve their precious water content under the burning sun. But life has not stopped, and an inner clock is still running. In a glass display case in a Mexican museum, a branch from a cactus from one of the country's burning deserts was exhibited. It was kept away from both water and direct sunlight, but for seven years in a row, it flowered at the same time as the mother plant in the desert.

Let us go to a totally different level - to the sun's magnetic field. The electrically charged gases, which constitute the visible, physical sun, are in constant movement inside the sun. This generates a powerful magnetic field. At intervals of 11 years this magnetic field is turned upside down, whereby the north and south poles of the sun switch place. During this period, the solar cycle activity is visible as so-called sunspots, including gigantic eruptions and coronal mass ejections. These eruptions influence electricity grids and radio communications on Earth, with a climax in the middle of the 11-year cycle. The solar activity also affects satellite electronics, and the astronauts at the International Space Station will postpone any spacewalking when a major solar activity is expected. [17]

At a growing number of universities around the world, medical students learn about chrono-medicine, the study of our body's rhythms and their effect on our health. This medical discipline is part of an overall chrono-biological research area, dealing with the rhythms of living organisms, including the connection to the rhythms of the planets and the sun. It was already well known in antiquity that many marine animals mate at full moon. [18] As humans, our reproduction, sleep, blood pressure, and other health parameters are affected by the

moon. However, more evidence is needed concerning the connection to births, traffic accidentss, crimes, and suicides. The word 'lunatic', originally from Latin meaning 'moon-sick', may not have been plucked out of thin air. [19, 20]

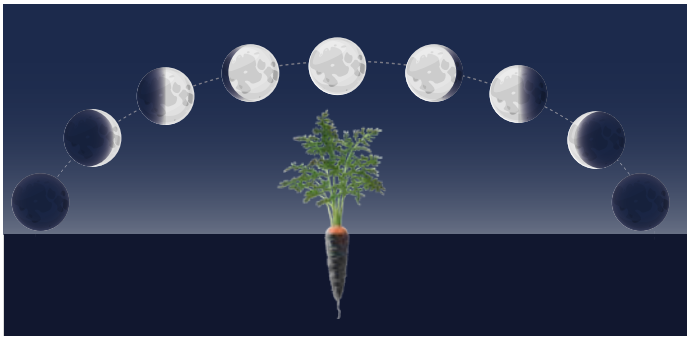
Moon rhythms and plants

Our agricultural plants are affected by the rhythms of the moon, and not just by the full moon. A biodynamic researcher performed an extended, systematic study of the connections between plant growth and the following five moon rhythms: (1) full moon/new moon; the synodic rhythm; (2) ascending/descending moon, i.e. how high the moon is in the sky; the tropical rhythm; (3) the moon's distance from of the Earth, varying from 363,000 to 405,000 km; the anomalistic rhythm; (4) the moon's passage through the 12 Zodiac signs; the sidereal rhythm; and finally (5) the movement of the moon in relation to the ecliptic, the plane of the Earth's orbit around the Sun; the Draconian rhythm.

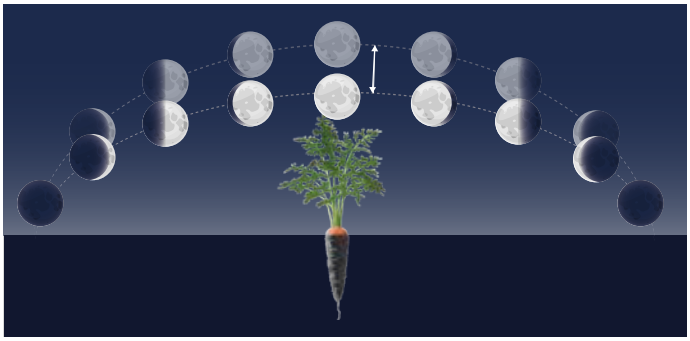
The experiments included five crops – carrot, potato, radish, bean, and rye – and ran over a total of 13 years. A few decades ago, results from this type of research would have been impossible to analyse statistically, since the five rhythms do not occur separately but constantly overlap. However, with the help of modern advanced statistics it was possible to analyse these complex phenomena. The results were indeed surprising. For the synodic rhythm, carrots which were sown 1–3 days before the full moon gave a higher yield, whereas potatoes gave a lower yield. Winter Rye had better germination percentages as well as germination speed when sown at full moon. For the tropical rhythm, a significantly higher yield was found for bean pods when the moon was at its highest position. For the anomalistic rhythm, all five crops responded with higher yields when sown when the moon was closest to Earth. Concerning the sidereal rhythm, for nearly all crops clear differences in yield and quality were found, however these coincided with effects from the synodic, tropical, and anomalistic rhythms. For the Draconian rhythm, no significant effects were found for any of the crops. [21] Figure 8 opposite illustrates the four significant rhythms.

Today, many biodynamic farmers use Maria Thun's sowing and planting calendar. Here, the focus is primarily on the sidereal rhythm, whereby the 12 zodiac signs are connected to the four elements – earth, water, air, and fire – and further to the four parts of a plant – the root, the stem/leaves, the flower, and

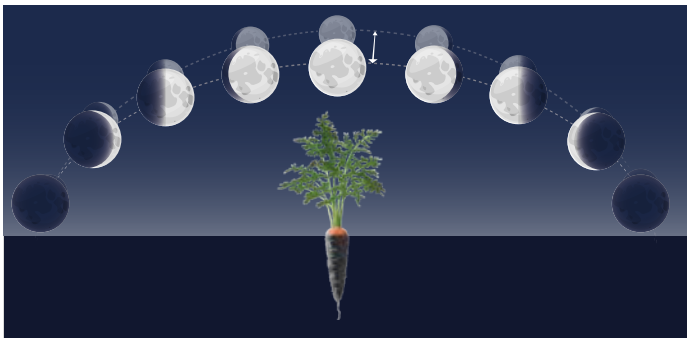
Figure 8. *Illustration of the four moon rhythms which have been shown to affect crops.*



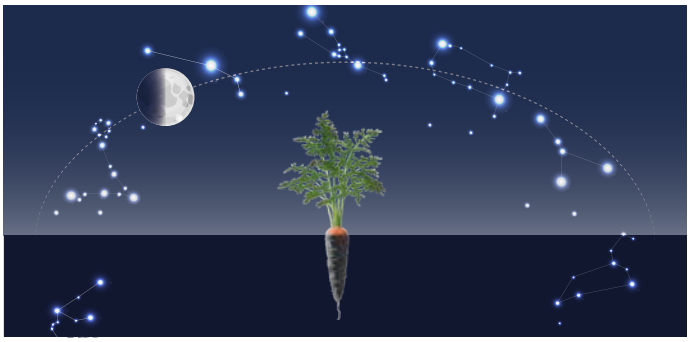
***Full** Moon/**New** Moon; the synodic rhythm*



***Ascending**/**Descending** Moon, i.e. how high the moon is in the sky; the tropical rhythm*



*The Moon's **distance to the Earth**, varying from 363,000 to 405,000 km; the anomalistic rhythm*



*The Moon's passage through the **12 Zodiac signs**; the sidereal rhythm*

See also Figure 9 on the following page

the seed, respectively. When weeding or tilling the soil during a period when the moon passes through the fire/warmth signs of Leo, Sagittarius and Aries, it will give the soil a specific warmth impulse. This may positively influence not least oil crops, generating a higher yield and oil quality. Since the moon passes through all 12 signs roughly within a month, there will be recurring possibilities of influencing both field and garden crops throughout the season. [22]

When comparing the complex interplay between four moon rhythms, and, on the other hand, the emphasis on the sidereal rhythm in Thun's calendar, we face a challenge. A possibility could be that a specific plant family is more sensitive to one or two of the moon rhythms than to the other rhythms. This would correspond to the different ways in which the flowering is triggered in different plant families. Some plant families are influenced primarily by the intensity of the light, while others are influenced by the length of the day. With regard to the effect of the moon passing through the different regions of the Zodiac, natural science has no explanation whatsoever.
One might think that these discoveries are altogether new, but this is not the case. For more than 2,000 years forestry practices for tree felling have been carried out in observance to moon rhythms. Here, the general rules specify-

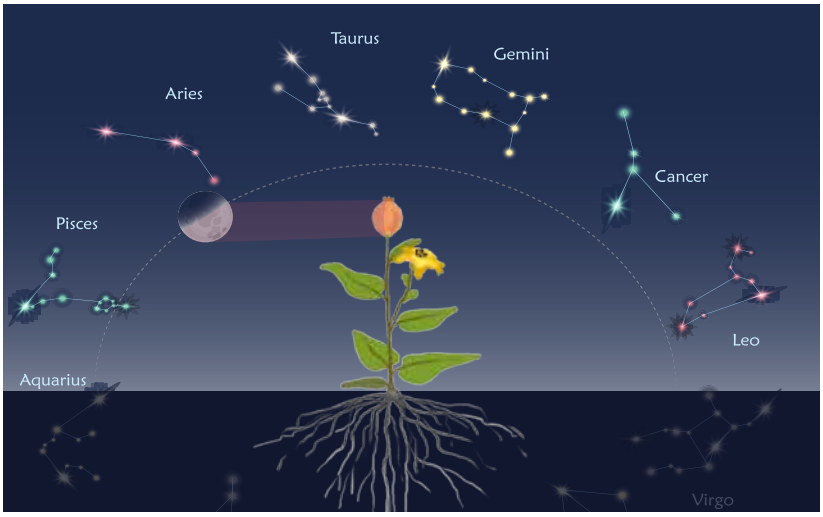


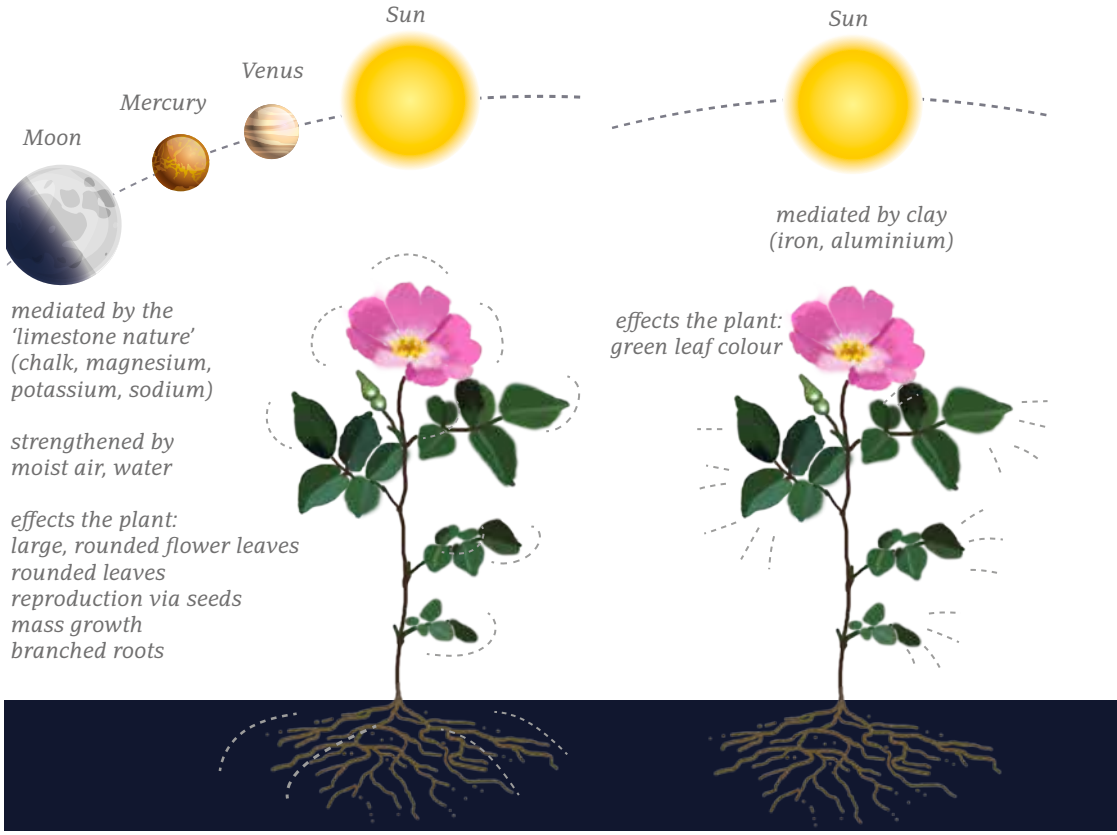
Figure 9: *Illustration of the sidereal moon rhythm, the primary rhythm applied in the Maria Thun Biodynamic Calender'. Here, the Moon is passing through the 12 Zodiac signs, divided into four groups each affecting specifically the growth of the root, the leaves/stem, the flower, and the seed formation, respectively.* [22]

ing the felling of trees are strikingly similar across the continents, concerning mostly the synodic full moon/new moon rhythm, but also the tropical and sidereal rhythms. Even today, these rhythms may be specified in the contracts made between the companies selling and buying timber. [23]

The ABC of plant growth

In the Agriculture Course, Steiner presented an ABC for plant growth: "This, therefore, is an ABC for our judgment of plant growth. We must always be able to say, what in the plant is cosmic, and what is terrestrial, or earthly… We can trace the process quite exactly. Assume you have a plant growing upward from the root. At the end of the stem the little grain of seed is formed. The leaves and flowers spread themselves out. Now the earthly element in leaf and flower is the shape and form and the filling of earthly matter… On the other hand, the seed which evolves its force right up the stream (in a vertical direction, not in a circling round) – the seed irradiates the leaf and blossom of the plant with the force of the cosmos. We can see this directly. Look at the green plant leaves. The green leaves, in their form and thickness and in their greenness too, carry an earthly element, but they would not be green unless the cosmic force of the Sun were also living in them. And even more so when you come to the coloured flower; therein are living not only the cosmic forces of the Sun, but also the supplementary forces which the Sun-forces receive from the distant planets – Mars, Jupiter and Saturn." See Figure 10 for an overview of these phenomena. [24]

With regard to the formation of nutritionally valuable fruit tissue, Steiner explained: "In this connection let us now look at the plants themselves. Two things we must observe in the plant life. The first thing is that the entire plant-world, and every single species, can maintain itself – that is to say, it evolves the power of reproduction. The plant can bring forth its kind, and so on. That is the one thing. The other is, that as a creature of a comparatively lower kingdom of Nature, the plant can serve as nourishment for those of the higher kingdoms... Everything connected with the inner force of reproduction and growth – everything that contributes to the sequence of generation after generation in the plants – works through those forces which come down from the Cosmos to the Earth, from Moon, Venus and Mercury, via the limestone nature... On the other hand, when plants become foodstuffs to a large extent – when they evolve in such a way that the substances in them become foodstuffs for animal and man, then Mars, Jupiter and Saturn, working via the siliceous



nature, are concerned in the process. The siliceous nature opens the plant to the wide spaces of the Universe and awakens the senses of the plant-being in such a way as to receive from all corners of the Universe the forces which are moulded by these distant planets… The warmth brings out and makes effective precisely those forces which can work through siliceous nature, namely the forces that proceed from Saturn, Jupiter and Mars." [24]

For the planetary forces to influence plant growth, they must have carriers, just as oxygen is the carrier of etheric forces, and nitrogen the carrier of astral forces. Here, in 'the limestone nature', Steiner included minerals such as chalk, magnesium, potassium, and sodium. Correspondingly, in 'the siliceous nature', Steiner included silica and phosphorous. Finally, the sun is placed between these polar planetary forces, acting through minerals such as iron and aluminium.

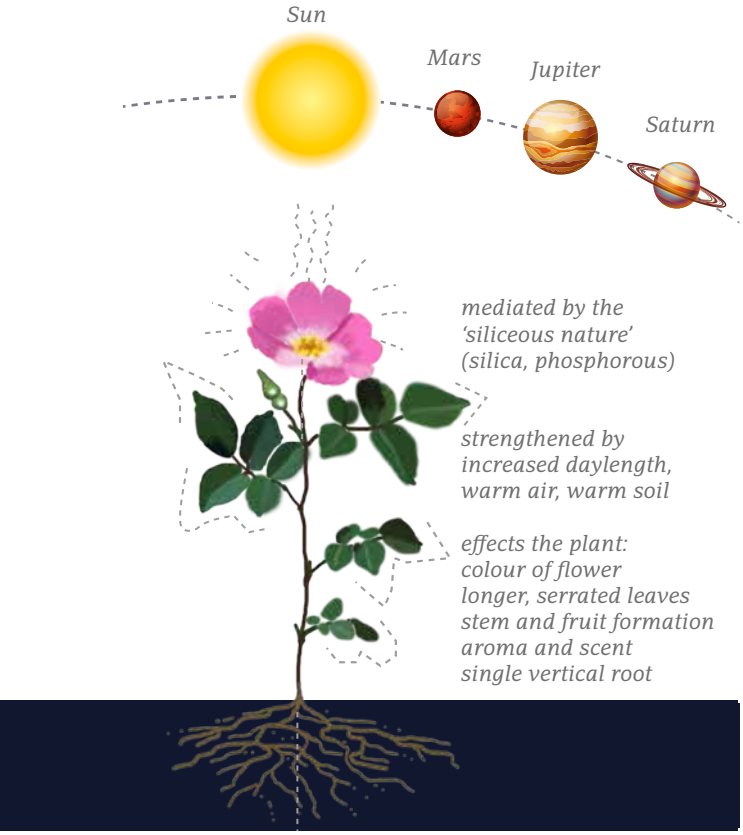


Figure 10: *The three groups f solar and planety forces which influence plant growth: Moon, Mercury, Venus, Sun (left), Sun (middle), and Sun, Mars, Jupiter, Saturn (right).*

The three groups of mineral elements which mediate the forces are: the limestone nature (left), clay (middle), and the siliceous nature (right).

The activity of the forces are strengthened by specific natural elements, including 'moist air, water' (left), 'increased daylight, warm air, warm soil' (right).
The effects of the forces on plant growth include for example 'large, rounded flower leaves' (left), 'green leaf colour' (middle', and 'colour of flower' (right) [24].

Plants, planets, and plant hormones

Can we connect this presentation of planetary forces to phenomena and observations known from natural science? Here, a biodynamic researcher has pointed to a striking correspondence between the effects of the planets, as described by Steiner, and well-known effects from five primary groups of plant hormone regulation systems which were identified in the 1950s. These five groups can be represented by the hormones Abscisic acid, Auxin, Ethylene, Cytokinin, and Gibberellin, respectively. Note that each group may include several closely related hormones. Thus, the group of Gibberellin includes no less than 74 hormones throughout the plant kingdom. [25]
Tests were carried out to verify the correspondences between Steiner's descriptions of the effects of the planets and the plant hormones. Here, a connection between the synodic full moon/new moon rhythm and the hormone cytokinin could be predicted, which was subsequently documented. Furthermore, a connection between Horn Silica preparation and Gibberellin was predicted. In a

major study, it was found that out of 47 plant physiological effects which are attributed to Horn Silica treatment, 44 are also attributed to Gibberellin.

Further, it was documented that plants may lose their sensitivity to the Horn Silica preparation when growing in conditions which strongly promote the growth phase, at the expense of the ripening phase. This sensitivity may be re-introduced by means of a parallel application of extracts from plants, including Digitalis purpurea. This is relevant not least in connection to the conversion of previously conventionally managed areas.

Note here that the human hormones are primarily regulated via our endocrine glands. These glands are the channels through which the human spiritual bodies influence our bodily functions. In a similar manner, we may hypothesise that the plant hormones are regulated by the etheric body of the plant. Even though the plant does not have energy centres/chakras such as those of humans, still the overall regulation of life processes takes place via hormones.

Demeter International – holding on to quality

Demeter is the brand for biodynamic products. Already in 1928, four years after the Agriculture Course, the first cooperative had been founded in Germany to market biodynamic produce, the Demeter symbol had been introduced, and the first Demeter cultivation standards had been formulated. Today, the Demeter standards and requirements exceed EU- and government mandated regulations for organic agriculture, by requiring specific measures to strengthen and protect the life processes in the soil and in food products.

In 1994, Demeter was the first organic certification organ to introduce standards for food processing. Today, only 22 additives are allowed for Demeter products, as compared to roughly 50 for organic products; nitrite and nitrate are not permitted; homogenisation and UHT treatment of dairy products likewise; and juices must be pressed juices and must not be made from concentrates and water. In 1997, 19 independent Demeter organisations from around the world came together to form Demeter-International.

A few years later the first Demeter Processing Standards were ratified worldwide. Today, more than 3,500 Demeter products are available in shops: vegeta-

Major differences between the Demeter and organic regulations [26]:

bles, fruits, baking products, meat products, dairy products, egg products, spices, oils, sweets, beers, textiles, cosmetics, toilet articles etc. As such Demeter is the biggest provider of organic goods world-wide. In 2020, rapproximately 6.400 farms with 210,000 hectares of land were certified in 62 countries. [26]

In 2020, the International Biodynamic Association (IBDA) and Demeter International joined forces to form the *Biodynamic Federation - Demeter International (BFDI)*. Hereby, biodynamic and Demeter organisations worldwide were united under an international umbrella organisation. The goals are to promote an agriculture that encourages mankind to take over the responsibility for the holistic development of the earth; that enables people to unfold their individual potential and develop their full consciousness; that produces wholesome and healthy food and other agricultural products of high quality to nourish body, soul and spirit; that fosters people to live and work together in dignity, mutual respect and tolerance; and which embraces the material and spiritual world and empowers mankind to be conscious of and embed the cosmic and terrestrial forces and substances. The spelling of agri-culture indicates that agriculture is indeed a cultural activity which is integrated into the development of humanity.

In 2020 the German magazine *Stern* initiated an interview study "Green Brands of the Year". A total of 32,700 German consumers were interviewed to identify which brands really represent sustainability, based on questions such as 'Who is reducing packaging?', 'Which products last particularly long?', and 'Which companies work with regional products?'. Here, the Demeter brand was identified as the most sustainable brand in the country. [28]

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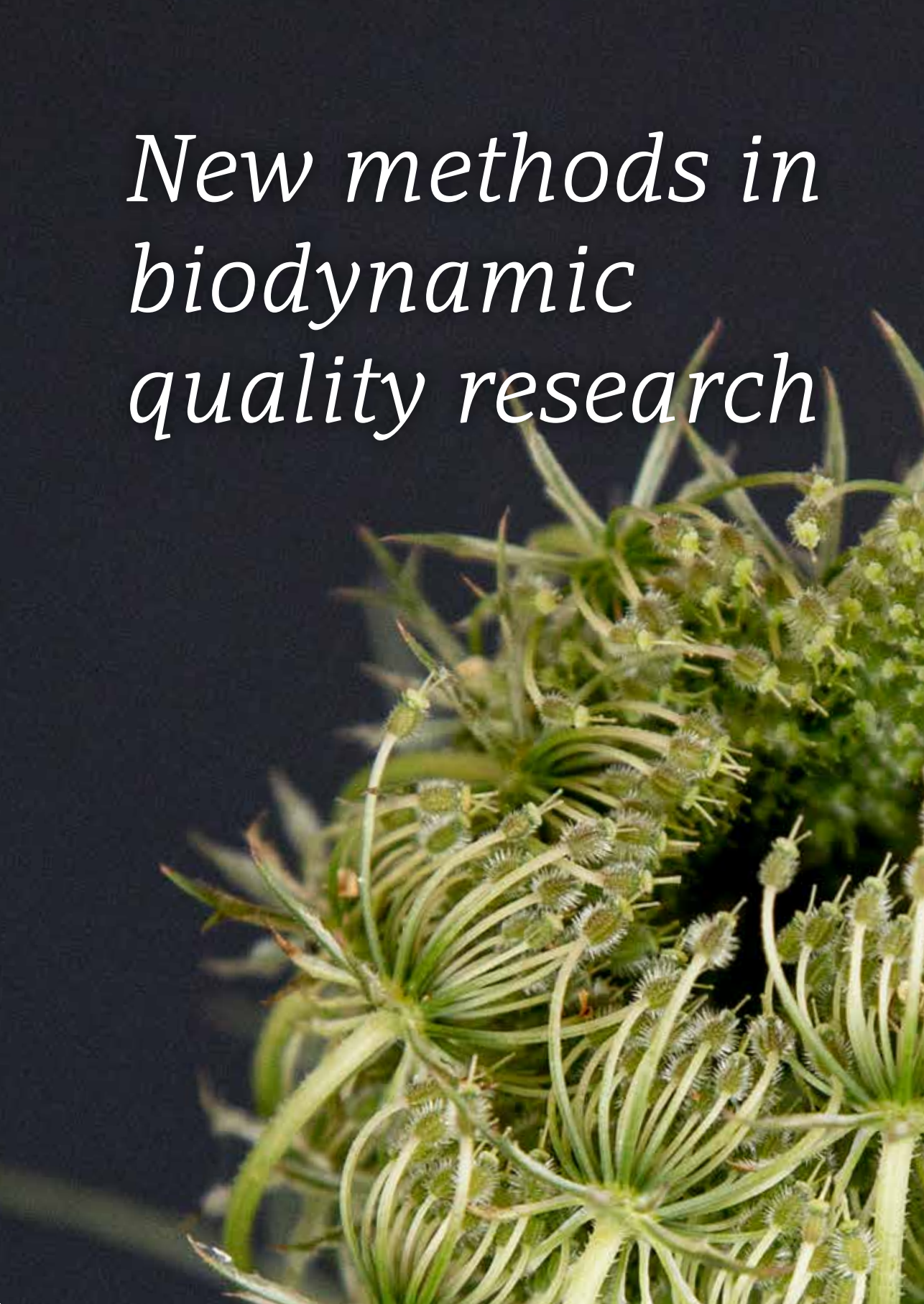
New methods in biodynamic quality research



4

In this chapter we shall look at a handful of methods which have been developed for answering questions connected to the activity of spiritual forces in crops and foods. Some of the methods date back to the very beginning of biodynamic agriculture, while others appeared during the last few decades. Today, these methods are applied almost exclusively in biodynamic food quality research.

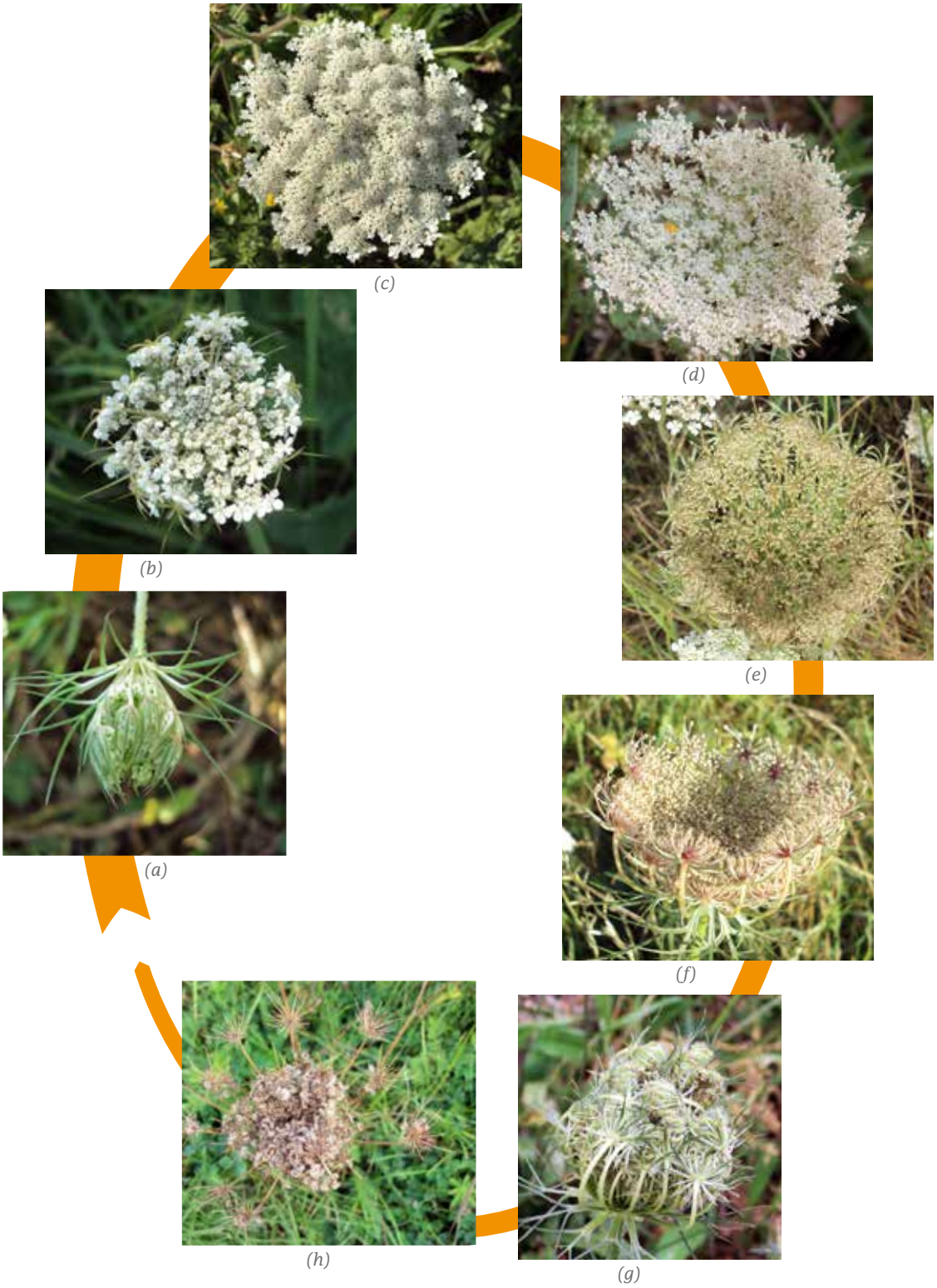
Plant metamorphosis

Let us start with a man who has inspired biodynamic research since the very beginning: Johann Wolfgang von Goethe (1749–1832). He is mostly known for writing world literature classics such as Faust and The Sorrows of Young Werther, but in 1810 he published a comprehensive study of colour. [1] Late in his life, Goethe stated that he did not think highly of what he had achieved as a writer, but that he was proud of what he had achieved in the science of colours.

In 1883, at the age of 21, Steiner was given the honourable task of editing Goethe's scientific works. While undertaking this work, he found that Goethe's approach to studying natural phenomena corresponded to the method which he himself used to study spiritual phenomena. This so-called phenomenological approach is based on meticulous observation which stepwise leads to valid concepts and a deeper understanding of the phenomena in question. Goethe emphasised that one must avoid abstract concepts and immature conclusions. He maintained that a growing number of observations will at some point arrange themselves in the right manner in the mind of the observer, and the necessary concepts and conclusions will emerge. Later, he summarised his method in a booklet entitled 'Experiment as mediator between subject and object'. [2]

Here, we will focus on his groundbreaking discovery of plant metamorphosis, which has inspired farmers, researchers, and others since the very start of biodynamic agriculture. The word 'metamorphosis' comes from Greek, and means a stepwise change in the outer form of an organism, such as we find it among insects: the egg turns into a larva, which after eating large quantities of leaves spins itself into a cocoon from which later a butterfly emerges and

***Figure 1**: Metamorphosis of the umbellifer flower of wild carrot (Daucus carota), illustrated based on various Danish sub-species. The major stages include: (a) the green bud is initially hanging down; (b) after rising to a vertical position, the upright flower will open, revealing numerous small, umbellifer flowers; (c) the inner part of the umbellifer flower will grow upwards, creating a convex bow; (d) when the flowering has taken place, the bow is reversed into a bowl-like shape, shielded by the outer ring of larger flowers; (e) gradually the whole umbellifer closes, creating a ball-like form in which the seed formation takes place; (f) finally, the ball opens up, and the seeds are free to fall and be blown away. [3]*


(c)
(d)
(b)
(e)
(a)
(f)
(h)
(g)

sets off into the sky. A very simple example of flower metamorphosis can be observed in the wild carrot. This ancestor of our domestic carrot, grows abundantly on roadsides, and in pastures, meadows, and fields without tillage, preferably in dry soils and in full sunlight.

See Figure 1 on page 99 for the major stages of this metamorphosis. Initially, the green bud hangs down; after rising to a vertical position, the upright flower opens, revealing numerous, small umbellifer flowers; the inner part of the umbellifer flowers grows upwards, creating a convex bow; when the flowering has taken place, this bow is reversed into a bowl-like shape, shielded by the outer ring of flowers; gradually the whole umbellifer closes, creating a ball-like form in which the seed formation takes place; finally, the ball opens up, and the seeds are free to fall and be blown away. [3]

Goethe's plant metamorphosis includes the gradual change in form, size, and colour of leaves, not including grasses and grains. He followed the process from the germinal leaves already found in the seed, via the stem leaves, the flower leaves, to the final leaves of the fruit formation. For years he struggled

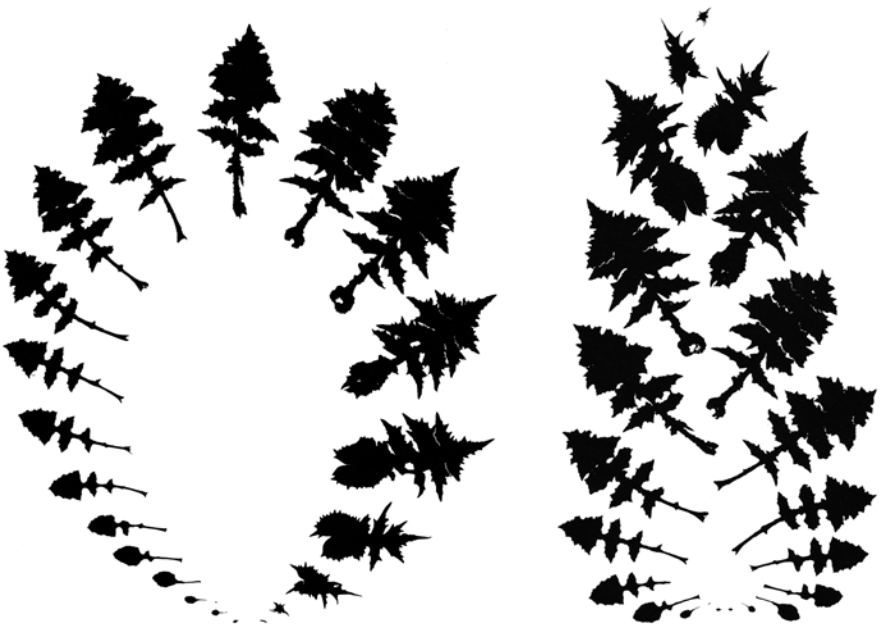


Figure 2: *Metamorphosis of the leaves of Sow Thistle (Sonchus oleraceus L.)* [5]

to find the overall ruling principle of what he observed. Then, in 1786–88, he travelled to Italy, where a breakthrough occurred, as we can read in his diaries: "While walking in the Public Gardens of Palermo, it came to me in a flash that in the organ of the plant which we are accustomed to call the leaf lies the true Proteus who can hide or reveal himself in vegetal forms. From first to last, the plant is nothing but leaf, which is so inseparable from the future germ that one cannot think of one without the other." [4]

For an example of plant leaf metamorphosis, see Figure 2 opposite. We can follow the emergence of the leaves as they gradually appear vertically on the plant. Initially, the two cotyledon leaves emerge from the seed, just above the ground. Then follows a stretching/expansion phase whereby the 'gravity point' of the leaves moves outward, the leaf becomes serrated into 5–6 distinct 'sub-leaves', and a contraction takes place whereby the 'gravity point' of the leaves gradually moves back towards the stem. Finally, the inner part of the leaves is shaped directly around the stem, and a tiny leaf appears just below the flower. [5]

Goethe introduced the concept of the Primal Plant (German: 'Urpflanze'), the invisible plant behind what we see with our physical eyes. He emphasised that this Primal Plant is not a theoretical concept, and that he indeed saw this plant with what he called his 'intellectual eye'. This raises the question of whether he spoke from a clairvoyant position. Clearly, the Primal Plant is what brings all these forms together: the invisible, dynamic 'primal leaf' which represents the continuity of the plant. The Primal Plant is not an attempt to trace the origin of all plants in any Darwinistic, evolutionary manner; instead, the metamorphosis concerns the unfolding of a specific plant. Here, it is argued that a plant's ability to undergo a complex leaf metamorphosis is a characteristic which is connected to the nutritional value of the plant. As such, the leaf metamorphosis may be used as a selection criterion in plant breeding.

In his final years, Goethe strove to understand the connection between the jaw formation of different animals. Thus, when he died, his study chamber contained numerous animal jaws; however, he had apparently not reached a full understanding of the interconnectedness of the different species' jaws. He quite deliberately stepped back from any attempt to study human jaws, stating that humans are too complicated. In recent years, some plant physiologists have shown an interest in his concept of metamorphosis, based on new discov-

eries in plant physiology and genetics. [6]

The picture-forming methods

In the 1920s, E. Pfeiffer and L. Kolisko, two of Steiner's co-workers, developed the following three so-called picture-forming methods for examining crop and food quality: (1) copper chloride crystallisation (also termed biocrystallisation); (2) circular chromatography; and (3) the rising picture method (also termed capillary dynamolysis). The common characteristic of the methods is that specific metal salts in watery solutions develop patterns which can be perceived as 'integrated wholes'. Thus, the output of the methods is not numerical data but indeed 'pictures'. Figure 3 below shows pictures produced by means of the last two methods. For a short presentation of the methods, see [7]. In the following, we will look at the biocrystallisation method in more detail.

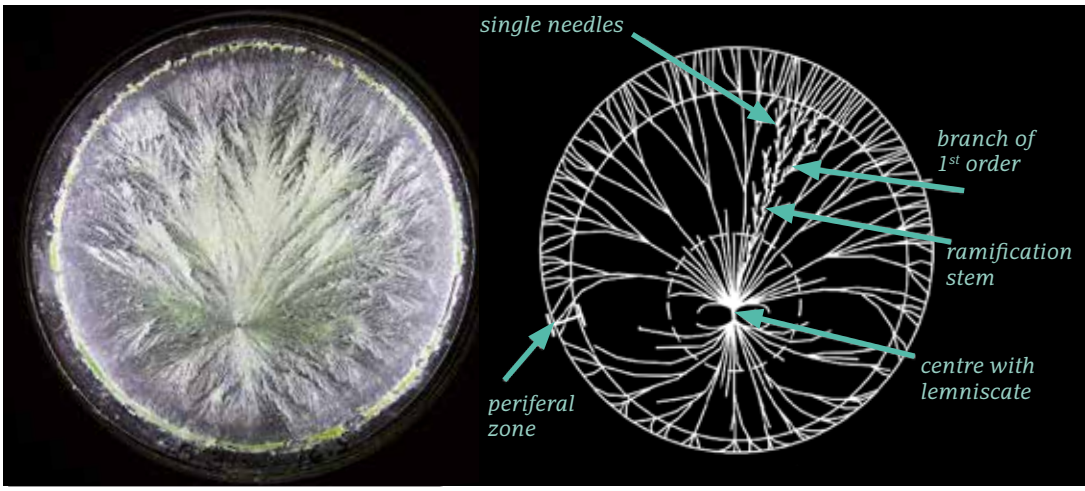
At some point, Pfeiffer asked Steiner how one could examine the etheric forces of living organisms in a laboratory. Steiner answered that one should find a reagent that will reflect the etheric forces, analogous to the way in which a pH-paper reflects the alkalinity/acidity of a solution, and that one should

***Figure 3**: Illustration of pictures produced using the three picture-forming methods; (a) a biocrystallisation picture; (b) a circular chromatogram; (c) a rising picture.*

experiment with crystallising salts together with plant juices. Copper chloride, the very first chemical salt which Pfeiffer tested, turned out to have unique abilities to discriminate between different ways of fertilising and cultivating crops. During the last years of his life, Steiner followed with interest the progress in Pfeiffer's work.

To produce a biocrystallisation picture, you need the following three elements: (a) a juice or a watery extract (the sample); (b) a watery solution of copper chloride (the reagent); (c) distilled/deionised water (the dilution agent). A glass dish with a diameter of 90 mm is used, into which a solution of 6 ml is pipetted. Further, you need an optimal combination of concentrations for the juice/extract and the salt, respectively. These are available from the literature, or they must initially be determined empirically. After 12–16 hours in the crystallisation chamber at 30°C, the water will have evaporated, and countless crystal needles will have appeared on the surface of the glass plate, constituting the 'picture'. In short, a biocrystallisation picture is a circular, coloured, 3-dimensional, zonal crystal structure.

Figure 4 below illustrates a biocrystallisation picture produced on the basis of optimum concentrations of sample and copper chloride, generating an op-



***Figures 4**. An optimal, 1-centred plant biocrystallisation picture, with several curved, integrated branches, each with numerous side branches with numerous side needles (left), and a stylised picture showing three zones, as well as branches and needles of different orders (right).* [8]

timal, 1-centred picture, with several curved, integrated branches, each with numerous side branches with numerous side needles. In this 'whole-picture', a centre zone, a middle zone, and a peripheral zone can be identified. [8]
Optimal plant pictures can only be produced based on plants which have had optimal growing conditions, including being fully ripe when harvested, and fresh when tested. Juice from carrots grown in a suitable soil, with an appropriate amount of fertiliser, precipitation, and sunlight will produce fully integrated 'whole-pictures'. If one or more of the growing conditions are not optimal during the season, the pictures will show various disturbances in the overall structure, as well as in the single branches and needles.

The method has primarily been applied to plant samples, for the purpose of differentiating crops and foods from different cultivation systems, of different varieties, and at different stages of ripening and ageing. During the last few decades, several articles have been published in international, peer-reviewed journals, see for example. [9,10,11,12,13,14] All these articles went through a process of detailed scrutiny from independent, experienced researchers.

On the opposite page, Figure 5 below shows a picture produced using only copper chloride, and pictures showing three stages of ripeness during the season. The carrots had relatively optimal growing conditions, including normal temperatures and precipitation. Samples were harvested in mid-June, in mid-July, and finally, in late August at normal harvest time. Thus, the pictures generated in mid-June were based on carrots which were still in active growth, showing a non-integrated picture divided into zones (lowerr right). In contrast to this, the pictures generated in August, based on ripe carrots, showed an optimal picture, with curved, integrated crystal branches expanding from the centre to the periphery, and a gradual transition between the zones (upper). Finally, the medium-ripe carrots generated in mid-July generated samples representing an intermediate stage between the two other pictures, and similarly, showing characteristics of an intermediate ripeness stage (middle).

The pictures can be evaluated using visual criteria as well as computerised image analysis. When evaluated visually, the quality is directly reflected in the visual criteria, in the overall integration of the zones, and in the regularity of the crystal branches, side-branches, and needles. It may be argued that the crystallisation process represents a 'fight' between the biological sample and the inorganic reagent. Copper is a mineral needed by all living organisms, but

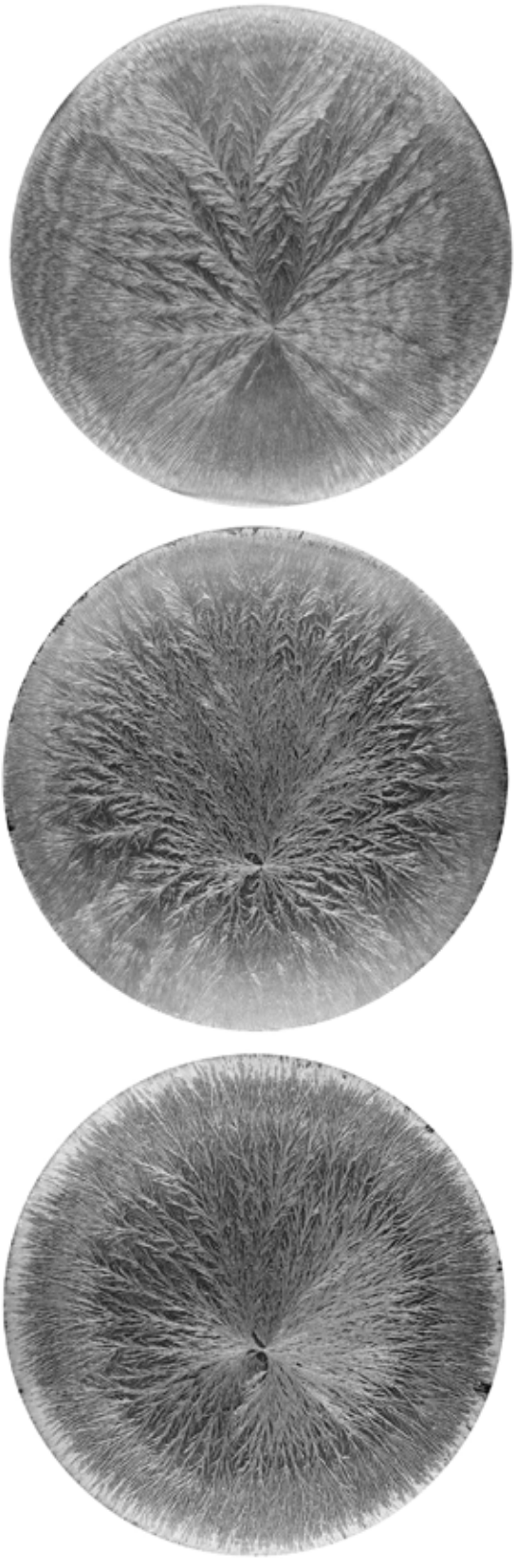


***Figure 5**: A biocrystallisation picture produced based exclusively on copper chloride (lower left), and carrot pictures from three stages of ripeness, as harvested in: (b) mid-June (lower right), (c) mid-July (middle), and (d) late August (upper), respectively.* [15]

only in minimal concentrations. At increased concentrations, the copper will be toxic to the cells and enzymes of the plant extract/juice. When the crystallisation starts on the glass plate, the concentration of copper is highly toxic; however, plant extracts/juices with optimal picture-forming qualities are still able to organise the crystallisation process, resulting in integrated whole-pictures. The ability to withstand the extreme pressure from the toxic salt is an aspect of plant vitality.

Renaissance of the picture-forming methods

In the 1980s and 1990s, the Swiss researcher Ursula Balzer-Graf inaugurated a new phase for the picture-forming methods, by applying all three methods simultaneously when examining crop and food samples. Also, she used three different concentrations of the juice/extract in question, as well as making pictures using stored juice/extract. Based on this broad approach, Balzer-Graf repeatedly examined wheat samples from the above-mentioned DOC trial, knowing only that the samples included two samples from each of the four cultivation systems: conventional (Conv-NPK), conventional + cow manure (Conv-Man), organic (Org; based on relatively fresh manure), and biodynamic (BD; based on composted manure). Generally, she was able to group the samples correctly, and subsequently to rank the organic and especially the biodynamic samples as having the best 'vital quality', whereas the two conventional samples showed the poorest quality, see Table 1 below. [16]

Year	Farming systems
1992	BD1=Org1 > BD2=Org2 > Conv-Man1=Conv-Man2 > Conv-NPK1=Conv-NPK2
1993	BD1=BD2 > Org1=Org2 > Conv-NPK1=Conv-NPK2 > Conv-Man1=Conv-Man2

***Table 1**: Grouping and ranking of coded wheat samples from the DOC-trial of 1992 and 1993, performed by U. Balzer-Graf, using picture-forming methods including biocrystallisation. The abbreviations BD, Org, Conv-NPK, and Conv-Man represent biodynamic, organic, conventional with NPK, and conventional with NPK+cow manure cultivation, respectively. The numbers 1 and 2 denote double-bulked wheat samples originating from four joined field replicates. The '=' denotes two groups of samples which were grouped as belonging to the same cultivation system. The '>' denotes that the samples on the left show better 'vital quality' than those to the right. [16]*

This was a major scientific achievement, documenting that systematic and recurring differences could indeed be found between the cultivation systems. The results sparked a renewed interest in the picture-forming methods. On the other hand, the results were criticised since the experimental methods applied had not been documented and published according to natural scientific standards. Further, Balzer-Graf was the only person who had performed this type of investigations. In 2001, inspired by Balzer-Graf's work, a cooperation between German, Dutch, and Danish researchers was started, with the goal of performing a comprehensive documentation of the biocrystallisation method. Such a process is formally called a validation, here including the functioning of the crystallisation chamber, the procedures applied in the lab, the visual evaluation procedures, as well as the computerised image analysis techniques applied. [17,18,19]

This documentation process is still on-going, focusing on the interaction between the physical conditions and the biological properties of the sample during crystallisation. [20] Further, a so-called Gestalt evaluation has been developed and applied, whereby specific overall characteristics of the ripening and ageing of vegetables, fruits, and grains have been identified. [21]. In short: The approach which Balzer-Graf applied can be both scientifically conceptualised and repeated by other researchers.

Biocrystallisation and spiritual science

The biocrystallisation method was intended and developed as a research tool for examining etheric forces under lab conditions, and to train the so-called intuitive judgement in perception. This latter judgement corresponds to what Goethe called 'anschauende Urteilskraft'. Here, a recent publication has demonstrated that an empathic engagement in the pictures - 'contextual sensitivity' - is a prerequisite in the visual evaluation of biocrystalllisation pictures. This involves an embodied simulation of the growth, curvature, wholeness and tension of the tree-like branches of the biocrystallisation pictures by means of what Steiner termed 'the senses of the will', including the sense of balance, movement, and life. For a short presentation of this topic, see [23].

Besides the above-mentioned results, it has also been shown that the method can differentiate between the effects of two different homeopathic high-potency preparations on plant growth. [24] These so-called D30 preparations con-

tain no physical molecules according to natural science, and as such we may assume that they indeed reflect effects of etheric forces. For more details on homeopathic preparations, see chapter 5.
We can argue that the picture-forming properties of plants reflect the vitality of the sample, as expressed in the ability to overcome the toxic effect of the reagent copper. We can argue that this vitality is connected to the proteins/enzymes, the carriers of the etheric body of the plant. From a spiritual scientific point of view, human health is based on a harmonious activity of the four bodies, individually and collectively. For plants, optimal 'whole-pictures' can only be produced based on fully ripe plants, meaning that their fruit formation has been completed, be it a carrot or an apple. Correspondingly, we can argue that an optimal 'whole-picture' reflects a harmonious activity of the bodies of the plant, the physical and the etheric body, as well as the higher bodies working from 'outside'. If the growth of the plant is over-emphasised, especially due to an excess of inorganic N-fertiliser, this will result in an imbalanced etheric activity, which will be reflected in non-optimal, non-integrated pictures.

Finally, we may expect that a future, closer cooperation between clairvoyant researchers and those working with the picture-forming methods will bring a deeper understanding of these questions.

Clairvoyance as a research tool

On numerous occasions, Steiner spoke about the development of human consciousness. Some 8,000 years ago, in the old Vedic culture of India, all humans had a clairvoyant perception of a spiritual world. On the other hand, they did not have an individualised, objective thinking, such as we know it today, and their interest in the outer physical world was much weaker than what we have today. This was expressed in the Vedic concept of 'maya', meaning 'illusion', meaning that the outer, physical world is not the 'real' world. In the subsequent Persian culture, humans began to relate more to the outer physical world, and a splendid agricultural culture appeared in Mesopotamia, between the Euphrates and Tigris rivers. This agriculture was based on the domestication of wild buffaloes, as well as the breeding of wild grasses into the ancestors of today's wheat varieties. This was followed by the Egyptian culture, with a human consciousness still more oriented towards the physical world, yet retaining some degree of clairvoyant insight into the spiritual world. Later, in

the Greek-Roman culture, this insight was further reduced, even in the Greek oracles and temples, while the ability to think logically grew stronger and gave birth to Greek philosophy.

Steiner termed our present culture the 'consciousness-soul period'. This started in the Renaissance, characterised by only small residues of this former spiritual insight remaining. On the other hand, we may today develop a fully individual self-awareness and an objective thinking. As humans, we have gained freedom from superstition and church dogmas; however, we have lost insight into the spiritual world. Steiner repeatedly emphasised that clairvoyant abilities can be developed, based on a transformation of our thinking, as part of a schooling of our three soul faculties: will, feeling, and thinking.

The ability to perceive etheric and higher spiritual forces is rudimentarily present in all humans and can be unfolded, based on committed exercises. During this process, the habits which are built into our will, feeling and thinking must be broken down, re-structured, and trained. Concerning our feelings and emotions, these are rooted in our astral body, arranged into a complex, subconscious pattern of sympathies and antipathies. These must be confronted and integrated anew. Hereby, the person will obtain an emotional balance and a deep-felt empathy. Concerning our thinking habits, one must be able to silence everything one has learned, in order to be able to make spiritual observations without prejudice.

The schooling of one's thinking includes developing the ability to concentrate for an extended period of time, to visualise in detail life processes such as those found in plants and animals, to place next to each other imaginations which in normal life lie far apart, and to observe one's subtle organ and bodily conditions and reactions. Further, a person embarking on a spiritual path will face some fundamental challenges, as prerequisites for a transformation of their thinking. In the spiritual world, everything is in continuous movement, and no solid objects are found, such as we know from the physical world. Moreover, our experience of past-present-future is replaced by an 'interconnectedness', relative to which our present linear space-time framework does not play a key role. Finally, the person must develop a strong moral character. Hereby, when spiritual abilities and powers start to appear, these will not be misused for personal interests.

The overall goal of the spiritual science which Steiner introduced is to re-connect the spirituality of the human with the spiritual world. In earlier cultures, people's spiritual development and insight were cultivated in occult schools, but today, based on the present individual I-consciousness, any individual with sufficient perseverance can develop some degree of spiritual insight on their own. The exercises described by Steiner will slowly transform our chakras, the energy centres of the etheric and astral body, and these will transform into clairvoyant sense organs. [25,26]

Contemporary clairvoyant research

Let us now turn to a contemporary framework for clairvoyant research, the German *Gesellschaft für Bildekräfteforschung* (Engl.: *Society for Research in Formative Forces*). [27] Here, some major points are presented from the descriptions of how to develop clairvoyant abilities, primarily on the etheric level. A basic starting point involves taking note of the existence of a so-called 'screen' on which we view our inner pictures, and on which our thinking activities take place. This screen lies in front of the head. Gradually, instead of using this screen for daily mental activities, it is possible to consciously make this space available for observing the etheric forces which are active, at the very least, in plants. [28]

Before reaching this point, one is confronted with an inner barrier which is characteristic of modern, Western persons. This barrier originates from a feeling of duality between the observer and the observed, a feeling which is emphasised by the approach to natural phenomena found in natural science. In contrast to this, the observation of etheric forces and spiritual beings is based on the ability of the person to merge to some degree with these forces and beings. The strict separation of subject and object which we find in the physical world is partly lifted. As humans, generally our I-forces are still weak, our ability to enter spiritual encounters is un-developed, and as such it is a protection to live in a subject-object world. We cannot observe etheric forces and spiritual beings without being influenced by them. Consequently, it is imperative that the observer exercises the ability to differentiate sharply between what is observed and, on the other hand, what the observer brings to the observation.

At some point, one will begin to observe some movements of etheric forces from plants. These are experienced as being 'directed with forcefulness', having a 'character' as well as a 'mood'. All this together forms a 'gesture'. Figure 6 on

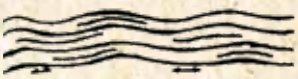
Gesture	Movement Form	Movement Mood
	inwardly spiralling movement	concentration into a ball (clenching), somewhat separated creating, individualizing
	fluid oscillating movement	gentle, selflessly carrying, supporting in the world
	braching flaring-up movement	gainful grasping, radiant conquering
	upwards and downwards flowing movement	enlivening permeation and envelopment, maintaining mobility
	upwards striving, opening movement	loving lifting and carrying, preserving and protecting of something lifted up
	coming together movement	driving and pressing together, solidifying, compressing

***Figure 6**. Examples of etheric gestures from plants.* [28]

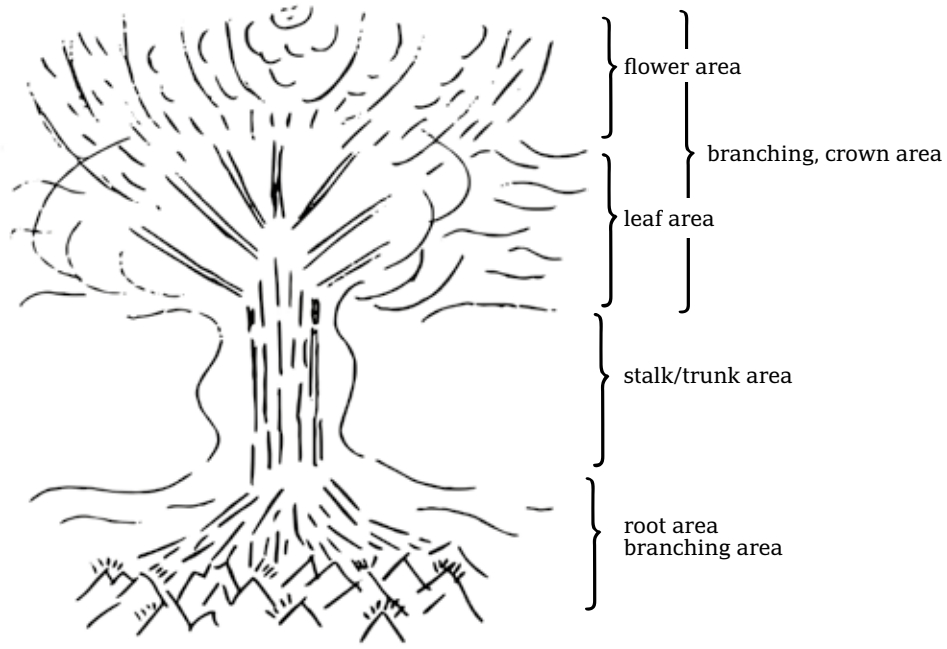


***Figure 7**. Common 'Light gesture' from plants.* [29]

the opposite side shows various single gestures, and Figure 7 shows a common 'Light gesture' from plants. The numerous types of formative, etheric forces which can be observed in the plant world can be summarised into three levels. The first concerns the specific gestures connected to the plant which stands before us, for example a carrot. The second level concerns the more general forces which are connected to the Umbelliferae plant family, and finally, the third level concerns the etheric forces which constitute the basic elements of plants: the sprout, the root penetrating the soil, the green leaves, the flower, etc.

Elemental beings

After having observed the etheric forces of plants for a longer time, the constellation of forces which constitute the individual plant will appear to the observer as a complex, typical entity. The question then arises: What brings all these diverse, individual forces together? What is the connection between the physical and the etheric plant? When deepening the observation of an individual plant, and then setting it all aside, a new spiritual level will appear, in which

beings are active. Hereby, the observer enters the world of elemental beings, and it immediately becomes clear that these beings are what keep the etheric forces together and what bring together the physical plant and the etheric forces. Thus, the order in which the observer deepens his/her observations is generally the following: sense perception – simple etheric forces – complex structures of formative, etheric forces – 'lower' elemental beings – 'higher' elemental beings.

On numerous occasions, Steiner described the world of elemental beings, and some months before the Agriculture Course he gave a series of lectures focusing on these beings. [30] For a contemporary presentation of elemental beings, see [31]. Here, we shall restrict ourselves to a short keyword description of the four groups of elemental beings which are deeply connected to the plant kingdom, and thereby to agriculture. The first group of beings are called gnomes and work in the ground, being an integral part of each root and germination process, and they are deeply connected to the minerals in soil. Furthermore, these beings are specifically connected to rainworms. In old fairy tales, which were originally brought forth by clairvoyant persons, such as the Brothers Grimm's tale 'Snow White and the Seven Dwarfs', these beings are depicted mining minerals and living in the root sphere of old trees.

The second group of elemental beings are termed undines and are connected to the water element and to animals such as amphibians. The third group consists of sylphs, the spirits of the air, which are specifically connected to birds. Finally, the fourth group of elemental beings are called salamanders, which are intimately connected to insects. In the case of a salamander and a bee, the connection is so close that it is extremely difficult for even experienced clairvoyant persons to differentiate the aura of the bee – that which is coming from the bee itself, from that which is coming from the salamander. Concerning the activity of the elemental beings, any activity which will promote, for example, the activity of rainworms, such as using compost and the biodynamic preparations, will affect the activities of gnomes.

Applied clairvoyant research

Today, the Society for Research in Formative Forces includes a spectrum of research areas, including meditation, food quality, breeding, planetary constellations, medicine, technology, and water quality. On the homepage of the

Summarised observations on the variety Aszita

The plant breeder: *…In the spring, the lower leaves will often turn yellow before the new leaves continue to grow. The leaf growth increases sharply towards the flowering stage, and tall, long straws acquire a slightly silver-grey colour, even before the awned, very loose spikes emerge and the colour mood is significantly enhanced. As it ripens, the top internode can turn a strong red-violet colour. Fast, joyful rise, withdrawal in spring, then strong increase in vitality with simultaneous intensive refinement in early summer towards flowering, with intensive ripening.*

The picture-former: *In all years and locations, the Aszita variety showed a very good ripening…. The vitality was very high. The proportion of degradative forces was low. On the overall structure level, the pictures were conspicuously regular and harmonious. As seen from comparative series and at the overall structure level, it is classified as a very high-quality wheat.*

The clairvoyant degustator: *Aszita shows a very beautiful, uniform gesture called the 'Silica gesture', as the original form of this gesture can be found in quartz. It is considered to be one of the main formative forces in nature. In the case of wheat, it often forms the basis of the varietal character. The Silica gesture opens like a funnel and creates space in the head and chest area. It assimilates light from above, which is radiated downwards into the limb area. The limbs are penetrated by supporting forces of a mineral nature. The gesture has a cleansing and clarifying effect, up to and including an emotional, even 'moral' tinge to devotion.*

Summarised observations on the variety Bussard

The plant breeder: *Roundish, semi-floury grains, quick germination, good emergence, and rapid growth. Vigorous growth in spring with relatively light leaf colour; the leaf colour only becomes darker with a very good supply of nutrients. Bussard shows only very little colour development in the leaf, as well as in the stalk and ear area. Rapid rise, rapid growth. Continuous youthfulness in growth, which, however, is overruled and held back by too early ripening.*

The picture-former: *The variety Bussard showed very poor ripening and low vitality for all years and locations. The share of degradative forces was high in 2004, with very cool or warm weather. At the level of the overall structure formation, the pictures were hardened and weak. Bussard is therefore at the bottom of the list of varieties.*

The clairvoyant degustator: *Bussard shows a very faint, shimmering Silica gesture, through which the body experiences uprightness. This gesture works successfully against sharp forces which contract, condense, and scorch everything living in the body. These forces are necessary for the development and deposition, for example of storage protein in the grain. Here, however, they are given excessive priority and have a devitalising effect on the body. In the soul, they leave behind a bald, sober consciousness that can be perceived as very sad.*

society's website, several examples of clairvoyant investigations are presented, together with references and literature. In connection with food quality, it is stated that the study of the formative, etheric forces is important for assessing the effects of specific foods on humans. Plants which are rather similar in their outer, physical appearance may appear much more differentiated in their etheric appearance. Since the etheric forces which make up a plant are similar to those which keep the human organism healthy, a study of the formative forces of plants is likely to generate results and insights which are highly informative regarding the nutritional value of foods. In addition, specific etheric forces may be 'overrepresented' in a plant, thereby generating unbalanced etheric structures which may promote specific diseases in humans.

Three ways of observing the etheric forces of plants are available, including (a) direct observation in nature or in a laboratory; (b) observation of the etheric forces when 'unfolding' from a watery solution/extract, by means of a rising picture procedure; and (c) degustation of, for example, grain kernels, during which the etheric forces are examined for their effects on the observer's etheric body and organs. This latter procedure is analogous to wine tasting – wine degustation – whereby highly trained experts can describe various layers of tastes, as well as subtle effects on their bodily wellbeing. When more people are active in clairvoyant research, it will be possible to develop procedures that will generate comparable observations among a number of persons, as a step towards achieving documented repeatability of clairvoyant observations.

Let us take a short look at an investigation based on a total of six wheat varieties which were grown over three years (2003–2005) in different locations. The goal of this investigation was to see in which way observations from three research areas - plant breeding, picture-forming methods, and clairvoyant research - can complement each other. In the two boxes below, the different observations are presented, to illustrate the language and concepts which the researchers used to describe the two varieties Aszita and Bussard, respectively. The first is grown in organic and biodynamic agriculture, while the latter for years has been grown in conventional agriculture, known for its high yield and desired baking properties. [32] See the former two box pages.

Additional remarks

On the homepage of the Society for Research in Formative Forces it is stated that the study of formative, etheric forces is important for assessing the effects

of specific foods on humans, and that specific etheric forces may be 'overrepresented' in a plant, thereby generating unbalanced etheric structures which may promote specific diseases in humans. This raises the question if indeed the emphasis on a high yield, in combination with a high content of hard gluten in conventional bread wheat breeding, has generated the ever-increasing allergic and intolerance properties of modern conventional wheat varieties. [33] The clairvoyant description of Bussard points in this direction: 'These forces are necessary for the development and deposition, for example of storage protein in the grain. Here, however, they are given excessive priority and have a devitalising effect on the body'.

Plant breeding

In 1922, a group of farmers went to ask Steiner's advice concerning an increasing degeneration which they had observed in seed-strains and cultivated plants. This was especially the case for wheat and potato, but also oats, barley, and alfalfa had shown signs of degeneration. The protein content of wheat had declined, and similarly, the vitality and taste of potatoes had declined markedly, as compared to what the farmers had experienced in earlier decades. Steiner pointed out that many plants had been 'violated'; they had been estranged from their cosmic origin to such a degree that by the end of the century their continued propagation would be unreliable. He recommended stopping cross-breeding and instead working with rigorous selection procedures, as well as breeding whole new grains based on wild grasses. [34]

To bring this recommendation into perspective, let us examine today's plant breeding techniques. Here, we may roughly speak of three levels of the plant organism on which the breeder can work: (a) the plant/plant population level; (b) the cell/tissue level; and (c) the DNA/gene level. The first type of breeding takes place in the plant's natural environment, while the selected plants are growing in the field. The resulting varieties are termed open pollinating (OP). The second type takes place in a lab by means of cell and tissue cultures which are treated with various chemical compounds including plant hormones. The third type takes place on the gene level. Here, methods of transferring a small part of a 'foreign' DNA into the DNA of a target plant have been used for decades by companies such as Monsanto and Syngenta. The resulting plants are referred to as GMO plants – genetically modified organisms.

The so-called F1 hybridisation concerns the cell/tissue level. Here, two different parent seed lines are inbred over many generations, thereby generating highly homogeneous parent seed lines. When crossing two such lines, highly homogeneous and productive hybrid seeds are generated, due to a so-called heterosis effect. Generally, these seeds are appreciated in organic agriculture for their homogeneous outer appearance and relatively high yields. However, the farmer cannot grow new seeds based on the F1 generation since the subsequent F2 generation seeds will generate highly heterogeneous plants. Consequently, the farmer must buy new hybrid seeds every year. The relatively few investigations that have compared hybrid seeds with open pollinating seeds indicate that hybrid seeds are oriented towards prolonging the growth phase, at the expense of the fruit formation. Thus, as a rule they contain more mono- and di-saccharides, as well as a smaller spectrum of plant-specific flavours. For a short presentation of the quality of F1 hybrid varieties, as examined using different methods, see [35,36].

During the last decade, the so-called CRISPR technique has been developed and applied world-wide. It can be described as a DNA scissor that can accurately and cheaply cut genes from all living organisms, from bacteria to humans. Not surprisingly, this technique has been presented as a way of creating new crops, not by inserting foreign genes into a plant, but by removing specific undesired genes from wild plants.

Today, we know that genes are not sufficient to explain the life processes of living organisms. When it comes to breeding, we know that plants adapt to their local growth conditions, to such a degree that their genes are regulated and even altered. They actively adapt to the local climate, to their neighbouring plants, to the local fungal diseases, and to the mycorrhiza present around their roots. This epigenetic approach has been central in biodynamic breeding from the start. Thus, we may assume that plants, when bred in the right manner, can re-establish their connection to the forces of the planets and the star world.

According to the international Demeter regulations, biodynamic farmers are only allowed to use seeds from plant/plant population breeding. Concerning the cell/tissue level, the so-called F1 hybrid seeds are allowed and widely used in organic agriculture, while biodynamic farmers may only use these if open-pollinating varieties are not available. With regard to GMO plants, both

Demeter and IFOAM regulations state that these do not align with the philosophy of organic farming. Also, a European Union regulation (848/2018, Art. 5) has stated that EU organic agriculture is GMO-free.

Concerning the goals of biodynamic breeding, let us take some statements from the Association of Biodynamic Plant Breeders: the goal is to breed varieties appropriate to human nutritional needs; to develop plant breeding linked directly to local conditions, thereby enhancing regional diversity; to breed varieties which are suited to organic growing conditions; to work with the selection and creation of variation based on natural crossing and transformation of the environment; to bring about mutual development between human beings, plant life, and the Earth; and to retain and strengthen the vital organism of the plant through diversification and regional adaptation. The breeding methods include classical cross breeding, and methods evolved from the foundations of biodynamic agriculture, including phenomenological observations and observations of the etheric forces of the plant. Further, it must be possible for varieties to be grown further by others, based on appropriate conditions for this further breeding. [37]

Ideally, plant breeding should take place on each farm: 'A farm is true to its essential nature, in the best sense of the word, if it is conceived as a kind of individual entity in itself – a self-contained individuality. This ideal cannot be absolutely attained, but it should be observed as far as possible. Whatever you need for agricultural production, you should try to possess it within the farm itself, including on the farm, needless to say, the due amount of cattle.' [38] However, successful breeding involves a major amount of both endurance and devotion, specific skills and equipment, as well as finances which few farmers can mobilise, in addition to the basic farm work. Thus, the most realistic approach is to perform breeding on a regional basis, based on a cooperation between farmers and breeders. The breeding will in certain areas benefit from a coordinated effort on a national as well as an international level.

Let us take wheat as an example of biodynamic plant breeding. Initially, the farmers and the breeders will identify which qualities should be emphasised in the new varieties, as compared to the existing varieties. Here already, the complexity of breeding becomes clear: Each wheat variety should be vital, with strong roots for gathering the nutrients and forces needed for its growth; the plant should use the light effectively and contribute to humus building in the

soil by excreting carbon compounds from the roots, thereby stimulating the microorganisms of the root zone; the plant should be able to compete successfully with weeds, and in the case of mechanical weed management the plant must tolerate rough treatment of its roots; during the growth season the plant must be robust, not least towards fungal attack, and it must ripen in an optimal way, including sensory and nutritional qualities for body, soul, and spirit; wheat varieties grown by farmers for baking purposes should have a suitable content of high-quality protein and gluten; finally, the plant should have a good storage ability and a good germination ability for the next season.

If the breeder puts too much emphasis on a single quality, other desired qualities will be reduced. Thus, breeding is an art of balancing a spectrum of qualities to achieve a harmonious plant. To evaluate the quality of the harvested wheat, the breeders cooperate with researchers using the methods which are presented in this chapter, including: picture-forming methods, clairvoyant investigation, sensory tests, and biophoton measurement.

For an example of a wheat variety from a German compendium of available grain varieties, see the pages 122-123, presenting a reduced sheet version. For all five yield and quality indicators listed (yield, protein content, sedimentation value, falling number, general quality index), high values are generally desired. This compendium is intended to serve as a guide for farmers for choosing the most appropriate varieties. Here, the descriptions shown include observations from the growth, results from the picture-forming methods and clairvoyant description, together with a few additional quality indicators. [38]

Today, it is increasingly agreed among grain breeders that the modern, conventional, high-yielding wheat varieties are associated with a reduced digestibility, which may generate gluten and wheat intolerance, and even celiac disease and gluten allergy. [39] In Denmark, among 'green' consumers, it is generally agreed that organic and biodynamic Dinkel, Emmer, and Einkorn, as well as older wheat varieties, have better digestibility. This growing awareness of the health effects of both cultivation and variety is mostly followed by a willingness to pay a higher price for organic and biodynamic breads and grain products.

***Figure 7**: Photos of three different Spelt varieties, as examples of what meets the breeder's eye during a breeding process: resp. Edelweißer, Gletscher, Copper.*

Variety sheet for the winter wheat Ataro

Variety characteristics

Has proven itself in terms of yield and quality since 2006. Suitable for more intensively cultivated locations. Shorter than the other Kunz varieties, with large ear. High gluten content with good dough firmness (Swiss classification: Class 1). High yield potential. A sufficient supply of nitrogen and water is a prerequisite for high quality.

Ataro is characterized by a very upright and strong growth. In spring the plant forms broad, dark green leaves and shows a forceful growth process. The leaf development is vigorous towards the appearance of the ear, the straw is upright and the ear loose. Ataro forms noticeably large kernels and is classified as medium in terms of ripeness. The processing properties are strongly influenced by the cultivation conditions. With a sufficient supply of N, very good baking results can be achieved. The extensogram values of the dough are in the good to medium range. The doughs are elastic and easy to process. High volumes could be achieved in baking trials. Properties such as shape and pores as well as the crumb and crust texture are good to very good.

Yield and quality indicators

Year	Soil type	Yield (t/ ha)	Protein (%)	Sediment. value	Falling numer	Quality index
2015		3.73	11.2	39	422	91
2015		2.6	12.6	50	451	
2015	clay	3.28	10.4	39	404	90
2014		3.78	10.3	26	170	94
2014		5.07	11	39	294	96
2014	clay	3.41	11.5	40	333	97

Extended quality investigations

Picture-forming methods

In the investigations, Ataro shows a moderate maturation and vitality in comparative series. In terms of whole-picture formation (German: Gestalt-ebene), however, the variety shows very well-expanded biocrystallisation pictures even with medium ripening. The type of stem expansion (German: Durchstrahlung) is an indication that the variety has a higher quality at the level of the whole-picture than can be derived on the basis of comparative series for ripening and vitality.

Soul-body effects

The composition of spiritual forces is quite unusual for wheat. In humans, its effect is to be found more on a soul than on a living organism level. The emotional and feeling ability centred in the chest area is grasped, shaped and permeated by powers of alertness and perceptual abilities. With the stimulation of the breathing intensity and depth, a laterally extending widening takes place and causes a more semi-conscious perception of the spiritual life on the inside or of the social togetherness (German: Miteinanders) on the outside. In the soul space which opens up, light and warmth phenomena with a flower-like character (German: blumen- und blütenartigen Charakter) can develop. [39]

Biodynamic vegetable breeding

We find in the European countries several smaller groups of breeders, engaged in bringing forth varieties which are suited to biodynamic agriculture. The largest of these companies is the German Bingenheimer Saatgut AG, located near Frankfurt am Main. Starting in 1987, the company developed from a group of biodynamic vegetable seed breeders. The present company was founded in 2001, with 80 registered shareholders, and with a turnover which in recent years has grown 5–10% annually. The seed producers hold ~20% of the shares. The business model is built around the company, coordinating the production and marketing of seeds from approximately 80 professional gardeners and farmers. A total of nearly 400 varieties are traded, of which 10% have been biodynamically bred. With a customer group of more than 2,000 professional gardeners, as well as nearly 6,000 home gardeners, the company is by far the largest of its kind. [40]

In 2004, the company launched its first consumer information project, in cooperation with the German biodynamic research ring, addressing consumers via shopkeepers and wholesalers. This activity has been continued ever since. The overall goal is to make vegetable breeding known and understandable to the consumer. This means that the consumer should understand the cultural task of maintaining and developing varieties, that carrot varieties have individual names, and that the varieties have specific properties which have a real role to play in our diet. Thus, out of a handful of carrot varieties, one is suitable for eating fresh, another for juicing, a third for cooking, and a fourth especially for children's tastes. Experience has shown that you can get this message through based on oral and written information, and on the other hand, based on the possibility of tasting fresh carrots as well as juices. Gradually, consumers come to appreciate the importance of growing open pollinating varieties, based on biodynamic cultivation, as part of a social and cultural endeavour.

Sensing beyond salty, sweet, sour, and bitter

Large companies selling processed food products, such as bread, dairy products, ice, frozen pizzas, etc., have one or more sensory panels as an integrated part of their product development. The panel members may be untrained consumers or expert sensory assessors. The members of an expert panel are selected based on documented sensory abilities, and they are trained regularly,

as part of the company's code of quality practice. For example, before launching a new type of bread a series of sensory tests will be performed to identify the bread type which meets the preferences of a specific consumer segment. The tests may include three types: (a) a hedonic test, whereby the panel members express their overall enjoyment of a product on a scale from say 1–10; (b) a product-specific bread test, performed by an expert panel, based on characteristics such as outer appearance, colour, aroma, taste nuances, flavour, texture, crumbs, elasticity, etc.; and (c) a food-induced-emotions test, using a questionnaire whereby the panel members score a product relative to how they feel after eating the product: e.g. content, rested, restless, energetic, relaxed, sleepy, tense, fresh, etc. [41,42]

Over the last decade, a so-called Empathic Food Test has been developed, inspired by the *Society for Research in Formative Forces*. [43] In 2016, the company WirkSensorik GmbH was established to provide a framework for applying the test, as well as for information activities. In addition, 'EmpathicFoodTest' and 'WirkSensorik' have been registered as trademarks, so that other companies cannot take over the test and use it for purposes which are not in line with those of the company.

A total of two panels are available: an untrained consumer panel, and an expert panel experienced with the Empathic Food Test. As part of the test, initially a 'body scan' is performed, whereby the mind is calmed down and body awareness is increased. Then, the panel members write down a free, first-impression description of the products in question, followed by a questionnaire with 12 bipolar attributes (warm-cold, light-heavy, energised-not energised, concentrated-not concentrated, relaxed-nervous, etc.). The attributes are rated on a scale of 1–5. Thus, for the pair warm-cold, the five levels of ratings include 'warm, rather warm, neutral, rather cold, cold'. As opposed to the 'food-induced emotions' tests, the Emphatic Food Test includes both emotional attributes, such as relaxed-nervous, and mental/bodily attributes, such as light-heavy and fresh-exhausted.

In a study three different groups of test persons were compared – untrained consumers, persons trained in industrial sensory panels, and persons trained in the Empathic Food Test – the latter group performed best in connection with testing the following four pairs of products: (1) natural mineral water from a plastic bottle vs. from a glass bottle; (2) bread made from the wheat varieties

Goldblume vs. Naturastar; (3) pasteurised organic milk vs. conventional pasteurised and homogenised milk; and (4) white crystal sugar from the Guarani vs. Südzucker trademarks. The persons trained in the Empathic Food Test were able to discriminate between the products based on nearly all 12 attributes.

Let us take another example of the applicability of the test: a blind taste test of a conventional roll product (Multigrain Rolls) vs. an organic roll product (Moin Organic Crusty Wholemeal Rolls). In the free description, the persons trained in the Empathic Food Test used attributes such as 'dull', 'heavy', and 'restless' for the conventional product, whereas attributes such as 'light', 'pleasant', and 'awake' were used for the organic product. Figure 9 below shows a 'body effect image' of the free descriptions. The green- and red-coloured text indicate positive and negative attributes, respectively. The number of attribute mentions are shown in brackets. Even 25 untrained consumers found differences between the products. After consuming the organic roll, the test persons felt significantly more awake. [44]

Finally, let us look at how foods can be affected by different types of light when displayed in a shop. This question is indeed relevant since the EU Commission has considered banning older types of light sources in favour of LED light sources. In this connection, an experimentwas conducted with quark products which were placed in: (a) a refrigerated display case at 50C for 30 hours while exposed to a light intensity of ~1,100 Lux from a modern Halogen lamp; (b) the same conditions as for (a), but with a modern LED lamp; and (c) darkness. A panel of 11 trained persons experienced, with regard to five of the emotional attributes from the Empathic Food Test, clear differences between the three types of lighting. Further, in the initial free description, the most positive attributes were found for the quark displayed in darkness, and the least positive attributes were found for the LED-lighted quark, while the Halogen-lighted quark held an intermediate position. [45]

How can we understand these results? Firstly, we should note that according to spiritual science, the number of human senses is not limited to the five well-known senses of seeing, hearing, smelling, tasting, and touching. Steiner included three 'lower' senses which concern our body, as well as three 'higher' senses. The lower senses are directed 'inwardly', termed the sense of life, movement, and equilibrium. Here, based on the life sense, we experience a range of feelings of wellbeing and the opposite, originating from our organs and bodily

***Figure 9**: Body effect image from a blind taste test of a conventional roll product (Multigrain Rolls) vs. an organic roll product (Moin Organic Crusty Wholemeal Rolls).* [44]

parts. The degustation of wheat kernels, mentioned in the section on clairvoyant research, represents a trained application of the life sense, sensing the effects of foods on the organs and bodily parts. Thus, persons trained in the Empathic Food Test have to some degree educated this life sense.

The light in our foods

Light from the sun is the basis for life on Earth. In seas and oceans we find algae and other marine organisms which can perform photosynthesis based on sunlight, and on land we find green plants. When speaking of our crops, light and life are intimately connected. We have seen how light and shadow influence the nutritional characteristics of plants. In shadow, an apple will not ripen fully, the level of undesired nitrates will remain high, and the number of desired vitamins and antioxidants will remain low, as compared to an apple growing in full sunlight.

In 1923, a famous experiment was performed by the Russian biologist A. Gurwitsch (1874-1954). He arranged two onions perpendicular to each other, so that the tip of root number 1, 'the emittor', was directed towards the cell division zone of root number 2, 'the recipient'. Then, he cut sections of the recipient root, and calculated the number of cell divisions, the so-called mitotic activity, of both the exposed and non-exposed halves of the root. Here, the recipient zone showed a significantly higher proportion of cell-division than the non-exposed side. Gurwitsch coined the term mitogenic radiation, and he proposed that this radiation is involved in the cellular communication of living organisms. [46]

This mitogenic phenomenon remained controversial for decades, until photons were documented in the 1950s and 60s, based on newly developed photomultiplier tubes. Photons are elementary particles, the carriers of electromagnetic and etheric forces connected to ultraviolet and near-infrared light. The so-called biophoton emission from living organisms ranges from a few photons to more than 1,000 per cm2 per second, corresponding to the brightness of a candle 20 km away. Still, by means of super-sensitive cameras it can be captured. Today, more than 1,000 scientific articles have been published on the topic of biophotons, including the role of these in the cell-to-cell communication of living organisms. Numerous articles have focused on the diagnostic potential of biophotons, especially in connection with the early detection and diagnosis of cancer. [47] For an overview of biophoton research in the human health area, see [48].

Fluorescence Excitation Spectroscopy

Inspired by the biophoton pioneer F-A. Popp, biodynamic researchers developed the biophoton technique further, terming it Fluorescence Excitation Spectroscopy (FES). A valuable characteristic of the method is that crop samples, such as vegetables, fruit, grains, and milk, can be examined directly, without being juiced or extracted beforehand. By means of colour filters, the sample is illuminated with different colours, after which the biophoton response is measured. Various data outputs can be calculated, which are suitable for different types of samples.

In this section, we will focus on results based on the so-called stable radiation phase, and on the ratio of yellow and blue colour emissions. A major conclusion from this research has been that samples in the vegetative phase have high levels of emission after excitation with yellow light, whereas seeds in dormancy, with a minimum of metabolic activity, have a relatively intense emission after excitation with blue light. The so-called R40 yellow-blue ratio has proven efficient in discriminating between samples in terms of different cultivation systems, processing techniques, and others. For an overview of the research performed, see [49,50].

Figure 10 on the following page shows stages of the ripening of apples, based on 12 apples on each harvest day. The curve shows that the whole apples became more 'fruit-specific' towards the final harvest day, whereas the seeds became more 'seed-specific'.

Concerning the cultivation of wheat, based on samples from the DOC trial, it was found that wheat grown with mineral fertilisers had a more vegetative character, while organic and biodynamic samples had more seed-specific characteristics. Further, results from a bean investigation will be presented. Here, biodynamic and conventional seeds of Trebona variety were cultivated in biodynamic soil and in an aquaponic production system, respectively. Hereby, four groups of beans (2 seed types x 2 cultivations) were available. From the resulting four groups of plants, beans were harvested, and the procedure was replicated, whereby a total of eight groups of seeds were available which had been grown biodynamically and aquaponically, respectively, for two years. The seeds tested for biophoton radiation were all taken from the second year of cultivation. Figure 11 below shows the results from the investigation. [49]

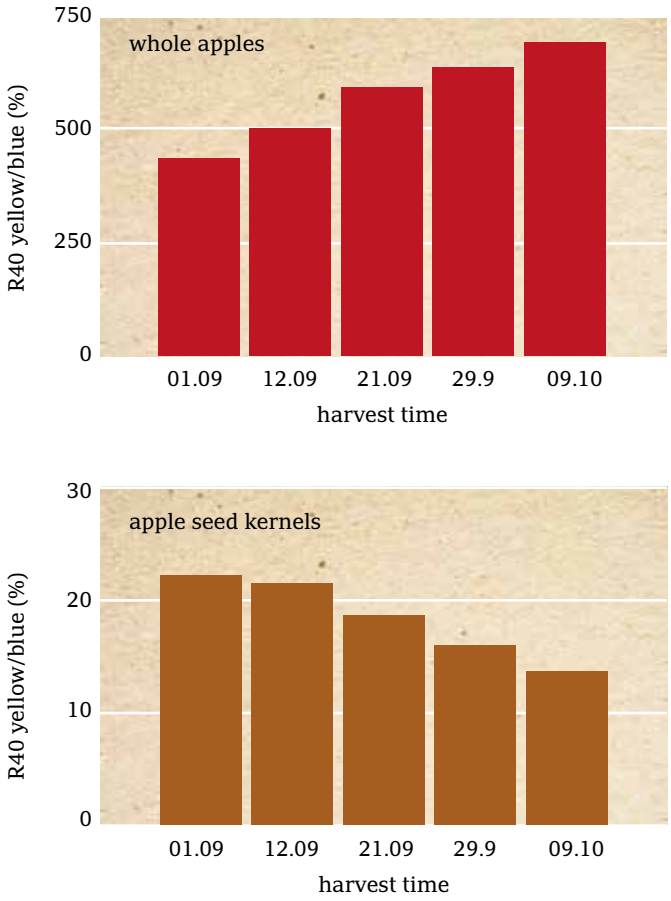


***Figure 10**: Biophoton radiation from apples at increasing degrees of ripeness of whole apples, investigated from September 1st to October 9th. The R40 value represents the ratio of biophoton emission immediately after illumination of the apples with yellow and blue light, respectively. The upper diagram shows the increasing degree of ripeness of the apples. In contrast, the lower diagram shows the R40 ratio of the apple seed kernels. Here, the more ripe the apple seed kernels are, the lower the R40 ratio.* [49]

As can be seen from Figure 11, lower R40 ratio values were found for the seeds which for two years had been grown in biodynamic soil, as compared to the two columns on the right. These results were based on seeds which had been grown in an aquaponic production system for two years. The lower values, found for the beans grown in biodynamic soil, implies that these responded

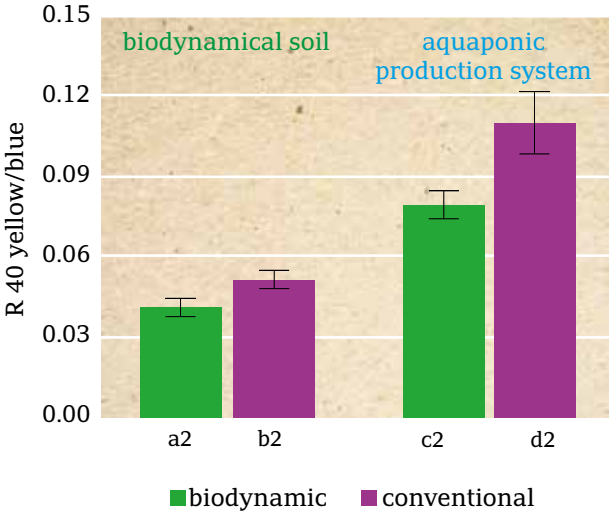


***Figure 11**: Results from an investigation of beans (Trebona variety) originating from biodynamic and conventional seed production, respectively. The two seed groups were cultivated in biodynamical soil (a1, b1) and in an aquaponic production system (c1, d1), respectively, whereby four groups of beans were harvested (2 seed groups x 2 cultivations) after the first year of cultivation. For these seeds, the procedure was replicated, whereby again four groups of beans (a2, b2, c2, d2) were available after the second year of cultivation. The figure shows the R40 values from these four latter seed groups.* [49]

with more seed specific R40 values. In contrast to this, the R40 values were markedly higher for the beans grown in an aquaponic production system, as shown in the two right columns. Here, lower values were found for the beans originating from biodynamic seed production. This implies that after two years of aquaponic cultivation, the biodynamic beans still had preserved some part of the original quality, as expressed in the lower R40 value.

Clearly, the Fluorescence Excitation Spectroscopy method has demonstrated an ability to discriminate between a large spectrum of samples, based on factors such as cultivation, light conditions, freshness, and physiological processes. [50,51] Generally, organic and especially biodynamic crop samples show the characteristics of fresh, ripe plants grown in full daylight. The coming years will no doubt bring new results and a deeper understanding of the connection between the results and the underlying activity of etheric forces.

Perspectives

Over the last few decades, biodynamic research has undergone a major development. On a recurring basis, scientific articles and theses are being published, documenting measurable effects from biodynamic preparations on crop and product quality, based on chemical analyses as well as on the complementary methods described above. Further, at many universities and agricultural schools, biodynamic agriculture is an integrated part of the curriculum on organic agriculture.

Generally, the results from the complementary methods point to a higher nutritional quality of biodynamic foods, as compared to conventional foods. Does this mean that the health authorities will start recommending organic and especially biodynamic foods? No, this is not the case. So far, no comprehensive human diet experiments have been carried out documenting that organic and biodynamic foods have superior food and health qualities. So far, the health authorities have not acted based on 'circumstantial evidence', but only based on 'substantial evidence', meaning human diet experiments.

Thus, a key challenge for biodynamic research is to bring about such diet experiments. Here, a spectrum of lifestyle factors, including drinking and smoking habits, bodily exercise habits, stressful factors in the everyday life, as well as exposure to harmful environmental factors, are in the way of drawing significant conclusions. Consequently, such diet experiments must include numerous persons which are followed over an extended period, and effects from various lifestyle factors must be taken into consideration. Not surprisingly, such experiments are very costly. In any case, the complementary methods presented above will be an integrated part of such experiments.

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Nutrition for body, soul, and spirit

5

In this chapter we shall look at the development of nutritional science, and on the other hand, we shall look at nutrition and health as seen from a spiritual science perspective. We shall see the role of earthly and cosmic substances, and the amazing uptake of substances via our breathing, senses, and skin. Finally, we shall see that biodynamic agriculture is a nutritional impulse, involving body, soul, and spirit.

Nutrition in natural science

Nutritional science is a young discipline, as compared to physics, which goes back all the way to the Renaissance. In around 1850, nutritional science was born out of chemistry on the one hand and medicine on the other. In 1926, thiamine was identified as the first vitamin and later termed vitamin B1. In 1932, vitamin C was identified, and its ability to protect against scurvy was documented. In the 1960s, the complex interplay between nutrition, our immune system, and infections was documented, and later the importance of trace minerals, fibres, and antioxidants was understood. Today, the importance of specific secondary compounds for our health is documented, and that of the intestinal microbial flora for the development of our immune system and general health. It is commonly agreed that as humans we need in our diet roughly 12 vitamins, 20 minerals, fibres, carbohydrates as well as essential amino acids and fatty acids. For a short history of modern nutritional science, see [1].

Nutritional science is based on a concept of health which is based on a particular concept of the human being. The present definition of health, as used by authorities around the world, was coined in 1948 by the World Health Organization (WHO): 'Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'. [2] Today, in medical science, there is a search for a more practical concept of health, based on the resilience of the individual, on his/her ability to cope with the demands of daily life, as well as stressful situations, and to maintain a state of balance between the individual and his/her physical and social environment. [3] The human being is here seen as a higher animal with additional emotional, cognitive, and mental abilities.

Since the Second World War several diseases have accelerated in the US and Western European populations, including obesity, diabetes, food allergies and intolerances, digestive disorders, reductions in male and female fertility, stress syndromes, as well as dental, cardiovascular, cancer, and autoimmune diseases. These are called lifestyle diseases, since they are connected with a broader spectrum of factors such as poor eating habits, smoking, alcohol consumption, pollution, low levels of physical exercise, stressful work conditions, etc. We know that these diseases show up when indigenous populations replace their traditional foods with store-bought foods. Further, we know that specific health-promoting, secondary compounds are more represented in older, vin-

tage vegetable varieties than in modern ones, and we know that the nutrient content of today's vegetables, fruit, and grains has declined, as compared to earlier decades. [4,5]

Health from outside – and from inside

Indeed, our health is influenced by several external factors, but also by internal factors. Medical doctors have repeatedly reported cases in which people, despite a weak constitution, manage to stay healthy under extreme pressure and excruciating conditions. Here, the term *salutogenesis* was coined by Aaron Antonovsky (1923-1999), an Israeli-American socio-medical researcher who is seen as the first to emphasise the importance of our innermost attitude to life for our health. The word comes from Latin *salus*, meaning health and the Greek word *genesis*, meaning creation. Thus, *salutogenesis* means the process of health creation.

Antonovsky's starting point was the human ability to survive long-term, horrific conditions, such as those found in German concentration camps during the Second World War. This was in fact what some of Antonovsky's Jewish family members did. The food offered in these camps constituted a system-

***Figure 1**: The primary factors affecting our health.*

atic malnutrition, which in most cases was combined with hard, physical labour. Additionally, Antonovsky introduced the concept of *'sense of coherence'*, a deepfelt sense of meaningfulness in one's life. This meaningfulness may be sedimented at the deepest layers of the individual's soul/personality during childhood and adolescence, based on intimate experiences with emotions and personal relations, with social responsibilities, and with life's deeper, existential questions. He concluded in all earnest that under such extreme conditions, health is not about lifestyle factors such as smoking or diet, but about the individual's feeling of being rooted in a meaningful life. [6]

Weston A. Price, a nutritional pioneer

Let us go back in time and look at two of the nutritional pioneers from the English-speaking world, starting with Weston A. Price (1870-1948). He was educated as a dentist, and his interest in nutrition originated from the connection he observed between poor nutrition and various dental diseases. This prompted a lifelong study of multiple cultures, their dental health, and their nutritional habits and health. He carried out studies in Switzerland, Scotland, Ireland, Alaska, Sudan, Australia, Peru, Polynesia, and the US, looking for possible links between dental degeneration and diet. He left behind vast amounts of research material, including 15,000 photos.

In 1939, Price published *Nutrition and Physical Degeneration* [7], in which he concluded that diseases which were widespread in Western cultures in the 1920s and 1930s, ranging from dental caries to tuberculosis, were rarely found in non-Western cultures. He found that when non-Western cultures adopted Western patterns of eating and living, the incidences of typical Western diseases soon increased. He found that mothers in non-Western cultures who ate animals and fat had easy deliveries and children with well-formed jaws and facial bones, a and that the opposite was found in the babies of mothers eating a westernised diet, where physical degenerations could be followed from one generation to the next. Clearly, Western methods of commercially preparing and storing foods reduced the presence of vitamins and minerals necessary to prevent the diseases observed. Furthermore, he found that modernisation in agriculture could lead to a depletion of the soils, whereby plants and animals lacked some of the nutrition they needed.

Generally, the non-Western diets contained animal products of some kind,

some even in high quantities, and no entirely plant-based or vegetarian diets were observed. The animal products in the diet were fermented, such as yogurt and cheeses, made from raw full-fat milk from animals grazing on nutritionally rich soils. Interestingly, these cultures often had 'sacred' food which was given to pregnant and breastfeeding women, young children, and sick people, including for example liver, cod liver oil, fish eggs, and butter from the mid-summer period.

Robert McCarrison, a nutritional pioneer

McCarrison (1878-1960) was an English doctor who joined the Indian Medical Service and was posted as a medical officer to Indian troops guarding the mountainous Northern Frontiers. He founded the Nutritional Research Laboratories, and later he was appointed Director of Nutrition Research for all of India. He pointed to malnutrition as a major cause of physical inefficiency and ill health among the masses in India. He summarised his research findings in the book *Nutrition in Health and Disease*. [8]

Today, he is mostly known for his documentation of the impressive health and robustness of the Hunza people, living on the Northwestern border of India, in a landscape dominated by huge glaciers and towering mountains. Apart from eye disorders, caused by the open fires placed in the middle of their huts, the Hunzas were unusually healthy, fertile, and long-lived. Their primary foods were whole grains, leaf vegetables, legumes, fruit, milk, milk products, and eggs.

Furthermore, McCarrison pointed to other reasons for their unusually good state of health: infants were reared on their mother's milk; adults drank herbal teas; and the surrounding landscape required vigorous exercise of their bodies. Still, he placed the factor of foods be fore all the others: 'I know of nothing so potent in maintaining good health in laboratory animals as perfectly constituted food; I know of nothing so potent in producing ill health as improperly constituted food. This, too, is the experience of stockbreeders. Is man an exception to a rule so universally applicable to the higher animals?' [9]

McCarrison became famous for a series of experiments with albino rats, with the goal of examining how the health of these omnivorous rats was influenced by the diets eaten by three different, large populations: (a) the Hunzas and the Sikhs in North India; (b) the Bengali and Madras populations of South India,

for whom rice was the cornerstone of their nutrition; and (c) the working class population of England, eating white bread, margarine, sweetened tea, a little boiled milk, cabbage and potatoes, tinned meats, and jam. With regard to the 'Hunza rats', the results were stunning: for more than two years, no case of illness was reported; and but for a few accidental deaths, no infant mortality occurred. Both clinically and at post-mortem examination this stock was remarkably free from disease. In contrast to this, the 'Bengali rats' suffered from a wide variety of diseases involving every organ of the body such as the nose, eyes, ears, heart, stomach, lungs, bladder, kidneys, intestines, the blood, glands, nerves, and reproductive organs. In addition, they suffered from loss of hair, malformed and crooked spines, poor teeth, ulcers, boils and became vicious and irritable. Finally, the 'English rats' developed most of these latter troubles; in addition, they were nervous, biting their attendants; they lived together unhappily, and after three months they began to kill and eat the weaker ones among them.

Healthy plant-based diets

It is important to realise that we do not eat nutrients. Increasingly, researchers speak of 'the food matrix', which provides functionalities which are different from those exhibited by the individual components [10]. Furthermore, we eat meals which can be characterised in terms of their long-term health value. Health authorities around the world provide 'advice on foods, food groups and dietary patterns to provide the required nutrients to the public to promote overall health and prevent chronic diseases', as stated by the Food and Agriculture Organization of the United Nations (FAO) [11].

During the last few decades several positive health effects from plant-based diets have been documented, including the lowering of blood pressure, reduced risk of heart disease and stroke, prevention of specific cancers, and lower risk of digestive diseases and type 2 diabetes. [12,13] In addition, the present focus on climate change has promoted the development of strategies for sustainable, climate-friendly diets, based on vegetables, fruit, whole grains, legumes, nuts, plant-based protein, fish, moderate consumption of dairy products, less meat, and avoidance of processed foods. These diets are associated with better health, as compared to typical Western diets. [14]

Alternative clinics have claimed for decades that a plant-based diet has ben-

eficial effects on various cancer diseases. At the Swiss Paracelsus Clinic, doctors and nutritionists treat hundreds of cancer patients each year, including patients with breast cancer, prostate cancer, leukaemia, and lymphoma. The clinic, which is not funded by the health authorities, combines dietary therapy with a spectrum of other therapies. The treatment involves three basic elements: (a) detoxification, whereby the body is initially purified from various toxic compounds; (b) strengthening of the organs and the intestinal flora; and (c) a diet based mainly on raw vegetables and juices, which the patient is encouraged to continue after treatment at the clinic. Out of hundreds of women who were treated for breast cancer, only a small minority developed metastases after this combined treatment. Even though the cancer did not completely disappear, it did not spread to other parts of the body. Consequently, the patients were able to live months or even years longer, enjoying higher quality of life, as compared to patients who did not receive the treatment. Note here that in many cases the patients came to the clinic late in the cancer process, after a medical doctor had stated that he/she was not able to do more for the patient. [15]

***Figure 2**: Illustration of the primary diets eaten in Western countries.*

Conventional, organic, and biodynamic foods

When comparing crops and foods from different cultivation systems we are confronted with three basic questions. Firstly, are there differences between conventional, organic, and biodynamic vegetables, fruit, and grains? The answer is yes. We find significant differences in yield, nutrient content, content of secondary compounds etc. Secondly, can we explain these differences? Yes, we can explain them based on well-known differences in nitrogen fertilisation and plant physiology. Heavy use of inorganic fertilisers, especially nitrogen fertilisers, will make a conventional wheat crop grow in a state of physiological imbalance, small or large. Thirdly, are these differences nutritionally significant? This is the critical question, the question which for decades has sparked heated discussions.

Several studies comparing the nutrient composition of conventional and organic foods have been conducted, generally in favour of the latter foods, see for example [16]. In the case of wheat, we saw in the DOC trial a better protein quality for the organic wheat, and an even better one for the biodynamic wheat. The largest review study performed so far showed significant differences in favour of organic cultivation systems. This included major differences in the content of antioxidants and specific plant secondary compounds which are linked to a reduced risk of chronic diseases, neurodegenerative diseases, and specific cancers. [17]. The leader of this English research group was among the first to state in public that organic foods are healthier than conventional ones. For this he was fiercely criticised by conventional researchers and by the British health authorities.

So why are the health authorities not recommending organic and biodynamic foods as healthier? The reason is that as long as larger human diet studies are not available, which show systematic differences which cannot be explained by other lifestyle factors, the authorities will not take any committed steps. The so-called Parsifal study, including 14,000 children from five EU countries, investigated allergies in relation to lifestyle factors. The results showed a 30% reduction in cases of eczema and allergies in children with an anthroposophic lifestyle, and with a high intake of organic and biodynamic foods. [18] Despite the differences found, in favour of organic and biodynamic foods, the EU health authorities will not recommend organic and biodynamic foods in relation to child eczema and allergies. Instead, they will ask for intervention studies based on single compounds in the food, and not a whole diet.

Comparing effects on our emotional and mental states

Further, we can compare foods with respect to their effect on our emotional and mental states. To exclude differences in lifestyle, humans participating in a diet test should be chosen who live in relative isolation. In 2003, the German so-called nun study was conducted, which included 32 nuns from a Catholic convent who received in sequence the following diets: (a) ready-made conventional food; (b) freshly prepared conventional food; and (c) freshly prepared biodynamic food. Subsequently they received the whole sequence backwards, with each of the periods lasting two weeks. To evaluate the effects of the diets, various blood parameters were analysed, and an extensive questionnaire on well-being was filled out by the nuns at the end of each period. The questionnaire was based on standard procedures for recording psychological well-being and physical complaints. In the questionnaires the nuns supplied demographic data, their expectations regarding the change in diet, their subjectively experienced effects from the specific foods, the effects on exercise and leisure activities, as well as the effects on their psychological and physical well-being.

The results showed a significant decline in systolic blood pressure at the start of the biodynamic periods. In addition, these caused significant improvements of personally experienced physical well-being, mental activity, as well as a deepening of the nuns' spiritual life, as expressed in the questionnaires. Finally, there was a clear increase in immunological activity when the diet changed from ready-made to freshly prepared food. But, since there was no data linking the subjectively experienced well-being directly with physiological parameters, one might question the scientific value of the results. Although the study had relatively little objectively measured data, the emotional and mental effects reported represent important findings, as seen from a holistic view of the human being. [20]

Comparing effects on the environment

Finally, we can compare the effects of different cultivation systems on the surrounding environment. Global, conventional agriculture is characterised by an industrial input-output approach to agricultural production, with only a minor focus on the ecosystems in which the individual farm is embedded. Since the 1960s, serious negative effects have been documented from all the primary conventional inputs used, including inorganic fertilisers, pesticides, antibiotics, and GMO varieties. Let us look at some of the effects with a direct relation to human health.

Pesticide residues can reach humans in two ways, as residues on vegetables, fruit, and grains, and via drinking water. Various studies have documented the presence of several pesticide residues in drinking water in countries such as Germany and Denmark. In most cases the amount of residue is below official threshold values, and as such both the official and the public reaction to these findings has so far been moderate. However, from a scientific perspective this threshold approach suffers from a critical weakness: the pesticides are examined individually, whereas in real life we are exposed to several chemicals at the same time, including pesticides, cleaners, paints, solvents, medicines, perfumes, etc. Here, a given substance can increase or decrease the toxicity of another, generating a stronger cocktail effect.

A dramatic negative cocktail effect on the sexual development of male rats has been documented. Four groups of rats were each given a specific pesticide in their drinking water, while a fifth group received all four pesticides simultaneously. All concentrations were in accordance with official threshold values, and thus officially harmless. But the results were alarming. In one of the first four groups, sexual malformations were found in 10 percent of the new-born male rats, and in the fifth group, with all four pesticides combined, more than half of the rats had malformations caused by hormone disorders such as enlarged nipples, diminished prostate, and cleavage of the penis. The effects documented beyond doubt that a key sex hormone had been critically disturbed. As of today, we do not know to what extent such cocktail effects affect human male hormones. Similarly, we do not know the long-term effects of being exposed daily to say 20-30 pesticide residues well below the official threshold values. [21] Figure 3 opposite illustrates this experiment.

The challenge of identifying a combination of factors triggering specific diseases and bodily malfunctions is especially evident in the case of male sperm quality. Since the 1970s, the number of living sperm cells in the male sperm of US and European men has reduced dramatically. However, the primary factors behind this highly worrying development have not been identified. [22]

With regard to antibiotics, already in the 1940s, microbiologists informed US and European health authorities that if antibiotics were applied on a routine basis in animal production, multi-resistant bacteria would inevitably appear. In 2010, 80% of antibiotics sold in the US were used on farms, and in Denmark the corresponding number was around 70%. In 2014, the World Health Organi-

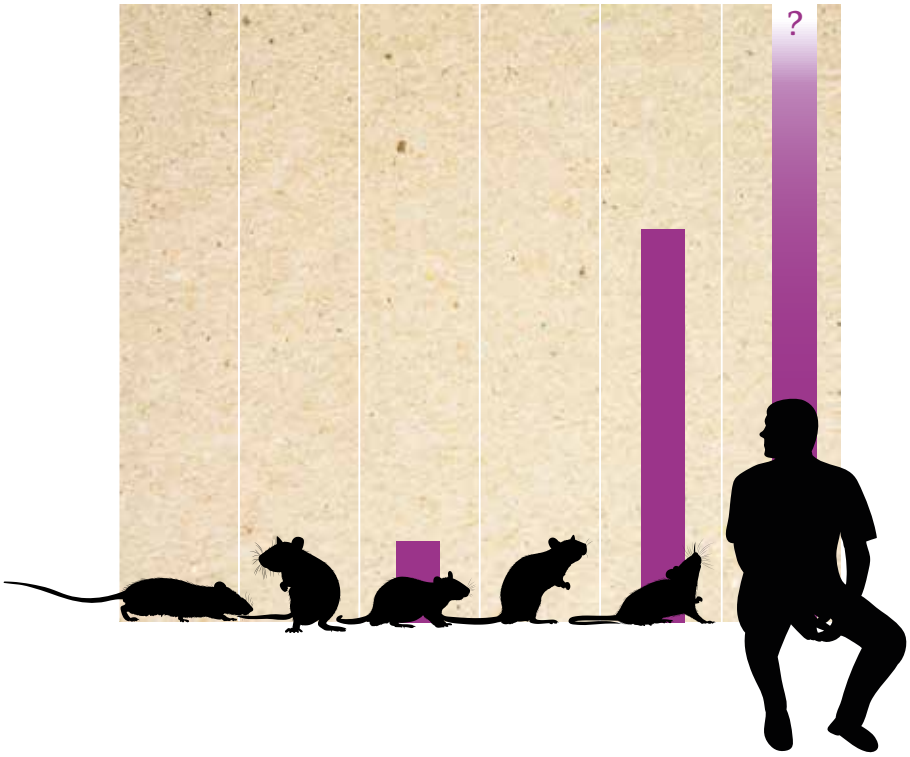

***Figure 3**: Illustration of negative 'cocktail' effects from pesticides in drinking water on the sexual development of male rats, though given according to official threshold values. Smaller effects were found from each of four single pesticides, however, when combining the four pesticides (outer right column), effects were alarming, with sex organ malformations caused by sex hormone disturbance, including diminished prostate and cleavage of penis. [21] The question is to which degree sub-clinical effects are present in boys, given that 25 pesticide residues can be found in drinking water on numerous locations in countries such as England, Germany, and Denmark.*

zation (WHO) concluded that the problem of resistant and multi-resistant bacteria had reached alarming proportions. Bacteria had been found that could not be killed with even the most efficient antibiotics available. US and Western European hospitals are painfully aware of especially four bacteria: MRSA, VRE, ESBL, and CPE. These are life-threatening, multi-resistant bacteria. [23]

Today, in Denmark, every person who is hospitalised is asked if they work with pigs or live on a pig farm. If so, they are checked for a specific MRSA bacteri-

um which has already caused a number of deaths. Modern conventional pig production has focused heavily on providing cheap meat, based on the routine use of antibiotics which are administered by the farmers themselves, in cooperation with a veterinarian. Consequently, multi-resistant bacteria have appeared, with a documented effect on public health. Pig production is no longer just another form of industrial production. Instead it is also a public health concern.

With regard to the spreading of genes from GMO crops, the so-called Bt maize has shown that a spreading is indeed taking place. The GMO gene produces a specific protein throughout the whole plant which is poisonous to specific larvae. This means that whoever eats the maize will take in the Bt protein. As a result, the official application for the commercial sale of Bt maize raised serious concern among researchers. New proteins in our foods can potentially generate allergy or intolerance responses if the proteins are not fully digested when entering the bloodstream from the intestines. The company Monsanto had provided the authorities with documentation showing that the Bt protein is completely broken down during human digestion and thus would not enter the bloodstream. Later, researchers analysed blood samples from 30 pregnant women and found the Bt protein in 28 of these, as well as in the umbilical cord of 80 percent of the newborns. In parallel, they analysed blood samples from non-pregnant women, and found the Bt protein in approximately 75 percent of them. [24]

Milk in our nutrition

It is universally agreed that milk from mammals is essential to the health of offspring in the first phase of life. But what about cow's milk and humans? Let us start with the raw, untreated cow milk, before the dairies start to process the milk. Here, the fatty acid composition is a good indicator of nutritional quality.

A healthy diet must contain specific poly-unsaturated fatty acids which our body cannot produce by itself. Here, a particularly valuable Omega-3 fatty acid is found. With the aid of this fatty acid, our body can synthesise the remaining essential fatty acids. Further, the ratio of Omega-6 and Omega-3 fatty acids can be taken as a nutritional indicator. This ratio should preferably be between 1:1 and 3:1, since a higher ratio increases the risk of various diseases. Unfortunate-

ly, the intake of Omega-6 fatty acids has doubled or even tripled in most Central European countries since the Second World War, a process which is still ongoing. In 2008, a Swedish dairy analysed the fatty acid composition of untreated milk from each of its 51 suppliers, consisting of 28 conventional and 23 organic suppliers. Figure 4 below shows on the horizontal axis all 51 milk samples, divided between conventional samples (red) and organic (green). The vertical axis shows the ratio Omega-6 to Omega-3 fatty acids. The red circle includes largely the conventional milk samples, while, with a single exception, the green circle includes all the organic milk samples. The average ratio for the conventional samples lies between 4 and 6, while the average for the organic samples lies between 1 and 1.5. Clearly the organic samples performed better. In parallel to the milk samples, the dairy registered the fodder used on all 51 farms. Based on this a pattern emerged: organic farms which fed the cows hay and grass silage showed the lowest Omega-6 to Omega-3 ratio, while conventional farms using a high amount of maize silage and imported concentrate fodder showed the highest, undesired ratios. [25]

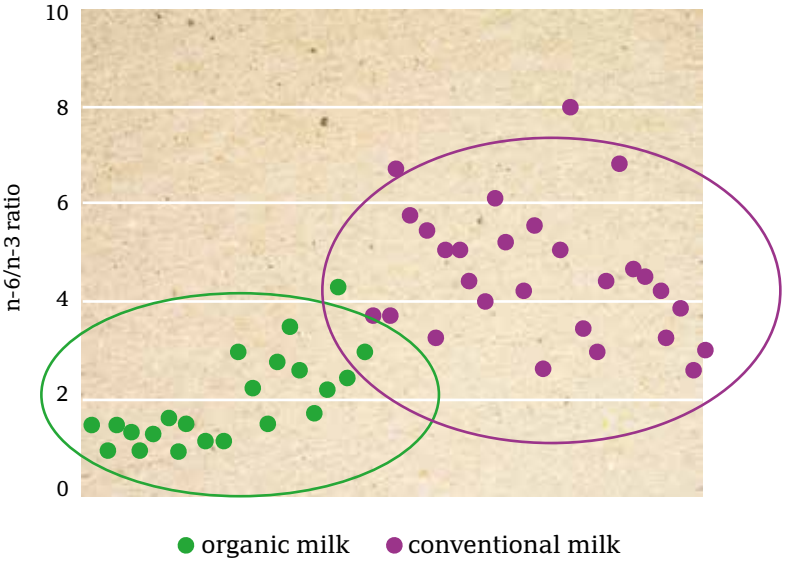

***Figure 4**: The ratio of Omega-6 to Omega-3 fatty acids in milk samples from 51 suppliers to a Swedish dairy in 2015, divided between 28 conventional (red) and 23 organic suppliers (green). The difference in ratio reflects the difference in fodder composition, with high ratios for high-input feeding* [25]

In 2014, biodynamic researchers performed a systematic study of these questions, comparing conventional and biodynamic milk samples originating from farms with low- and high-input feeding. Several fatty acids as well as antioxidants were analysed. The highest concentrations of nutritionally beneficial compounds were found in the low-input, biodynamic milk samples, and the lowest concentrations were found in the high-input, conventional samples. [26] Thus, the results corresponded with those of the Swedish dairy, indicating that, generally, organic and biodynamic cultivation and feeding practices promote the nutritional value of milk.

Vital milk from vital cows

Cows produce at least two enzymes – lacto-peroxidase and lysozyme - in their milk which can kill pathogens from the environment. Hereby, the calf is less exposed to bacteria which cause infections and diarrhoea. Lacto-peroxidase can handle extremely aggressive chemical compounds, by means of which bacteria are destroyed. Lysozyme is more familiar to us, since humans continuously secrete this from our tear glands so that bacteria cannot harm the eyes' ultra-sensitive surfaces. Some mammals such as the Tasmanian devil produce far more antimicrobial enzymes and peptides – specific active parts of proteins – than cows do. The immune system of new-born devil joeys is not fully developed, and the joeys are born in pathogen-loaded pouches. You might say that the mother supplies the unprotected joeys with an immune defence via her milk, until they are old enough to produce their own immune defence. [27]

It is simple enough to test this enzyme activity in raw milk. A portion of milk is poured into a sterile plastic cup and placed in a heating cabinet at 20°C, and over the next days the pH of the milk is measured at intervals, whereby the fermentation can be followed via the gradual lowering of the pH. [28] In connection with a Danish milk project I had the chance to test various organic milk samples this way, including milk samples from two organic farms with cows which were predominantly hay-fed, as compared to two organic farms with cows fed primarily on silage and a relatively large portion of concentrate fodder. All four samples contained a similar, low level of bacteria.

Figure 5 opposite shows the fermentation process of the two hay-milk samples (the two upper curves), and the two silage/concentrate-milk samples (the two lower curves), as reflected in how quickly the pH value declined over 96 hours.

The pH of the silage/concentrate-samples dropped from ~7 to ~4.5 within 48 hours (the two lower curves). In parallel to this, the consistency of the milk turned from liquid into that of soured milk, whereby the cups could be turned upside down without the soured milk flowing out. In contrast, after 96 hours the pH of the two hay-milk samples had not reached a pH of 4.5 (the two upper curves), and the milk was still liquid. [29]

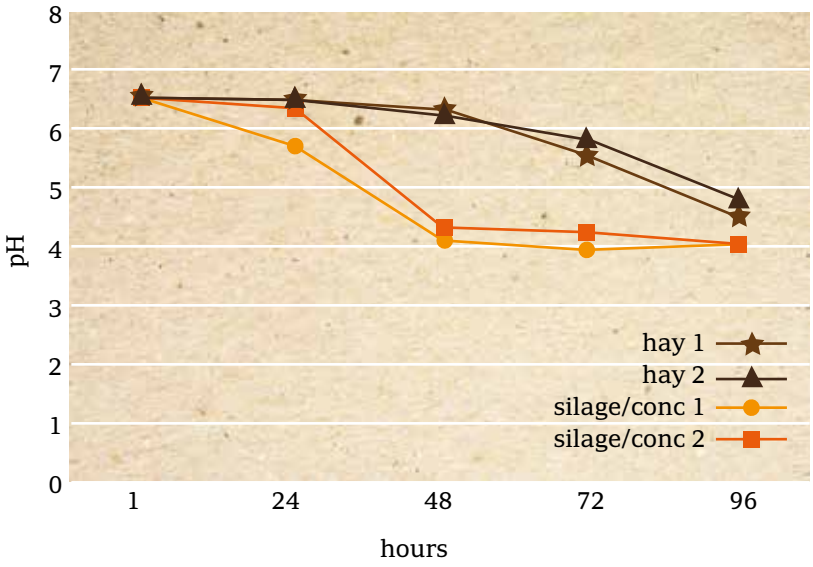

***Figure 5**: The fermentation process of four organic milk samples, including two hay-milk samples (two upper curves) and two 'normal' silage/concentrate-samples (two lower curves). The curves show the gradual decrease in pH over 96 hours.* [29]

What can we learn from this? We saw that the fatty acid quality of organic and biodynamic milk is better than that of conventional milk, due to the cows being fed with more grass and hay. We saw that the organic milk from hay-fed cows had more enzyme activity than the conventional milk which was produced based on silage and concentrate. Further, we saw in chapter 3 the increased ability of Salmonella bacteria to mobilise DNA-repair enzymes when fed with organic vegetable juices. Finally, we saw that the ability of plants to mobilise antioxidants against microbial attacks depends on the way they are fertilised. In all cases we can speak of various degrees of vitality, as reflected in the ability of the organisms to maintain their physiological balance despite serious or even life-threatening pressure. This ability is strongly influenced by fertilisation and feed, respectively.

Heating of cow milk – a serious health concern

It is well-established that children living in cities have a greater risk of developing allergies, as compared to children growing up on a dairy farm. In addition, children who drink unpasteurised farm milk in their first years have fewer immune-related problems later in life, such as asthma, allergies, and hay fever. These protective effects are attributed especially to the whey fraction of the milk, including specific immune-related proteins, as well as to the content of living lactic acid bacteria which stimulate the development of our intestinal microflora and the immune system. Currently researchers are working hard to produce a 'cowshed pill' which can support the human immune system. [31]

Milk allergy is the most common allergy in small children. Fortunately, most children outgrow this allergy as their immune system and enzyme production become more developed. [30] A milk allergy is defined as an adverse immune reaction to one or more proteins in cow's milk, including an IgE reaction whereby specific immune globulins appear in the blood. Milk lactose intolerance does not cause an IgE reaction, but instead symptoms such as headache, nausea, diarrhoea, and stomach pain.

A biodynamic researcher has, together with an official German allergy clinic, examined the allergic properties of two types of milk: (a) pasteurised and homogenised conventional milk; and (b) unpasteurised, biodynamic farm milk. A total of 11 children participated, drinking the two different types of milk

	Conventional farm	The biodynamic farm
Cow race	Holstein-Frisian	Older, local race
Number of cows	More than 100	Less than 50
Annual milk yield/cow	Average >10,000kg	On average 6,000kg
Primary fodder	Maize silage+concentrate	Grass, hay, own grains
Outdoor grazing	Typically none	The whole grazing season
Outdoor area	Typically none	All year round
Milk processing	Pasteurisation + homogenisation	None

***Table 1**: Characteristics of a typical, large, conventional high-input dairy farm, including the milk processing, as contrasted with the biodynamic farm supplying raw milk for the child milk allergy investigation.* [32]

separately for a week, with a one-week interval in-between. Blood samples were taken to see if the children reacted with an IgE immune response. The results showed that 7 out of the 11 children reacted with an IgE response to the conventional supermarket milk, whereas none of the children reacted to the biodynamic farm milk. [32] Table 1 below presents the characteristics which generally define conventional high-input dairy farms, and those of the specific biodynamic farm which supplied milk for the investigation.

Note that the results indicate that the present practice of testing a milk allergy by means of a pasteurised supermarket milk is not suited for determining a 'real' milk allergy, since the children did not respond to the biodynamic raw milk.

Following up on the initial investigations, mice were exposed to milk samples which had been heated in different ways. The results showed that the mice had a 'normal' allergic response to the conventional, pasteurised, and homogenised supermarket milk, whereas they did not react to the raw biodynamic milk. Further experiments showed that the mice reacted to the biodynamic farm milk when it was pasteurised. Furthermore, when the pasteurisation temperature was increased stepwise by 5°C, the mice started responding when the temperature reached 60°C, just below the so-called VAT-pasteurisation level (63°C for 30 min). Today, EU regulations require at least 72°C, but most milk in the EU is consumed as UHT milk, which has been heated to 135-145°C for a few seconds. The results indicate that the pasteurisation of milk is a potential allergenic factor for humans. Finally, additional experiments showed that when specific untreated, bioactive whey proteins were added to the pasteurised milk, the mice did not respond. These results point to a possibility for organic dairies to market milk as having fewer allergenic and intolerance properties. [33]

Already in 1980, a 10-generation rat experiment was performed, comparing the effect of raw, pasteurised (72°C for 15s), and UHT milk. A basic diet of 66% freeze-dried milk powder was used. The experiment ran over three years, representing roughly the lifespan of a healthy rat. Here, the growth, fertility, litter yield, and organ weight were registered, and a so-called histopathological evaluation of organ slices was performed. The researchers concluded that 'several comparisons between milk treatments showed statistically significant differences, especially as far as growth rates, reproductive yields, organ weights,

and blood analyses are concerned, but not with respect to histopathological changes. Raw milk was more efficient in stimulating growth than UHT milk, whereas pasteurised milk gave intermediate results.' The undesired effects were primarily attributed to the denatured milk proteins. [34]

In the 1930s, homogenisation of consumer milk was introduced by most US and European dairies. This is a process whereby the fat globules are broken down under high pressure into smaller units. We can assume that this adds to the denaturation of the milk which takes places when the milk is pasteurised.

Can you safely drink raw cow milk?

Can raw farm milk be sold in supermarkets, thereby preserving all the known and unknown health-promoting properties of raw milk? The answer is yes, on the condition that strict hygiene control is maintained at the farm, followed by a reliable cooling chain all the way from the farm to the consumer's fridge. In fact, in Eastern Europe there is still a strong tradition of public sale of raw milk. If you get off a train at the Main Station of Belgrade, the capital of Serbia, you will find in the main hall machines offering cooled, unpasteurised milk. In Denmark, after the Second World War and until 1957, unpasteurised milk from selected farms with strict hygiene control was sold, intended for children at risk of malnutrition, and no epidemics occurred. Today in Germany, there are just under 15 farms selling unpasteurised farm milk, so-called Vorzugsmilch. Similarly, no epidemics have been attributed to these farms. Recent investigations found no cases of contamination from a regulated sale of raw milk, based on strict regulations for both milk production and distribution. [35]

Various investigations have shown a markedly better fatty acid composition in organic and biodynamic milk, as compared to conventional milk. The nutritional quality of these fatty acids is closely connected to the fodder composition, whereby fresh grass and hay provide the best fodder. When we bring different studies together, we can follow the quality all the way from the fodder to the cow and further to the human mothers' milk. Here, a single study has shown that the fatty acid quality of the milk of mothers who consumed biodynamic dairy products improved as compared to the milk of mothers consuming conventional or organic dairy products. [36]

Milk and horns

It has been shown that the dehorning of milk cows negatively influences the milk quality, as reflected in the picture-forming properties of the milk. [37] The horns are used in connection with the recurring herd hierarchy manifestations among cows, but besides this the horns are an integrated part of the cows' heat regulation. Thus, an unusual amount of blood vessels are present in the inner, soft horn, in fact so many that a cow can lose a considerable amount of blood when losing the outer, solid horn under unfortunate circumstances. Consequently, the Demeter regulations prohibit dehorning, as well as buying cows without horns.

Milk as seen from a spiritual science perspective

Steiner pointed to an important difference between milk and meat consumption. Milk is intended for the nutrition of the calf, whereas this is not the case with meat. Therefore, speaking in terms of proteins, milk proteins have high nutritional value, whereas meat is made up of muscle protein with a lower nutritional value, as evaluated based on for example the content of essential amini acids. Further, according to Steiner, a plant-based diet strengthens the forces of the human organism which connect the human to the whole planetary and cosmic system. In contrast to this, a meat-based diet ties the human more tightly to the earthly sphere. Finally, milk supports the human in being an 'Earth citizen', without tying him or her too strongly to the earthly sphere. [38]

Biodynamic agriculture – a nutritional impulse

Shortly before the Agriculture Course, Pfeiffer asked Steiner the following: 'How can it happen that the spiritual impulse, and especially the inner schooling, for which you are constantly providing stimulus and guidance, bear so little fruit? Why do the people concerned give so little evidence of spiritual experience, in spite of all their efforts? Why, worst of all, is the will for action, for the carrying out of these spiritual impulses, so weak?' Then came Steiner's surprising answer: 'This is a problem of nutrition. Nutrition as it is today does not supply the strength necessary for manifesting the spirit in physical life. A bridge can no longer be built from thinking to will and action. Food plants no longer contain the forces people need for this.' [39]

During the Agriculture Course, Steiner presented a new understanding of agriculture, and of food quality. He stated that the task of spiritual science relative to agriculture was to offer means of treating manure in such a way that the soil would be enlivened, so that the plant can grow in a living soil and reach its fruit formation. [40]

As presented in chapter 2, an optimal fruit formation is a precondition for nutritious plants. In the following, we shall attempt to bring together these two aspects, the re-building of the bridge between our thinking and will to action, and, on the other hand, the plant reaching its fruit formation. This includes at least the following four challenging points: (a) describing the three-fold human being; (b) the human uptake of nutrients via the breath, the senses, and the skin; (c) the correspondence between the three-fold human being and, on the other hand, the plant organs; and (d) the formation of proteins and enzymes based on 'blueprints'.

The three-fold human being

The saying 'A healthy soil gives healthy plants which give healthy animals and humans' summarises the interconnectedness of nature's kingdoms. Human health is the last step in this health chain, implying a harmonious function of the physical body, the etheric body, the astral body, and the individual I, both individually and collectively. But when it comes to nutrition, we need to complement the clairvoyant description of the four human bodies with that of the three functional systems of a human being: (a) the nerves-and-senses system; (b) the rhythmic system; and (c) the limb-metabolic system. From an immediate point of view, the nerves-and-senses system is centred in the head, and, via the nerve cells and the senses, it is represented all over the body. This represents the 'upper' pole of the three-fold human being. As indicated by the term, the limb-metabolic system includes the limbs and the metabolic system of our body, including our digestive system. This represents the 'lower' pole of the three-fold human being. Between these two poles, we find the rhythmic system, centred in the lungs and the heart/blood circulation. This constitutes the balancing factor between the upper and the lower pole. Here, just as blood vessels are found everywhere in the body, the rhythmic system is represented everywhere in the body.

Nutrients via the breath, the senses, and the skin

Steiner stated that the physical foods that we eat serve only as a basis for building the nerves-and-senses system, the brain, and the senses. In contrast, our limbs, the metabolic organs, and the intestines are built entirely from substances which are 'condensed' from substances which are present in the air in ultra-low concentrations.

These 'cosmic substances' are taken up via the breath, the senses, and the skin. In contrast, the term 'earthly substances' represents the physical foods which we eat, and from which the nerves-and-senses system is built. The rhythmic system here holds an intermediate position. With respect to nutrition, Steiner gave no specific details concerning the rhythmic system.

Steiner repeatedly emphasised that the descriptions and instructions which he gave should not be taken as dogmas but should instead be tested thoroughly. This was the case with the biodynamic preparations which he presented during the Agriculture Course, and which were subsequently tested by the ring of farmers founded during the Course. Similarly, the highly controversial description of 'cosmic substances' must be tested.

But how can we test this? From natural science, we know that numerous minerals are present everywhere in the atmosphere in ultra-low concentrations, originating from rock erosion, sea salt, volcanic eruptions, soil, dust etc. We know that nitrogen from the atmosphere can be absorbed via our skin and exhaled via the breath. We know that substances absorbed via the cow's breathing during the milking can be found in the milk. And we know that so-called radioactive isotopes can be taken up via the skin. All this points to the possibility of using such isotopes for examining the human uptake of substances from the air via breathing, the senses, and the skin. However, since radioactive isotopes from oxygen, nitrogen etc. emit ionising radiation, these represent a health risk when entering our bloodstream, and so far, no such study has been conducted. [41]

The three-fold human being and the plant organs

We know from everyday life that coffee and plums have a stimulating effect on our digestion and intestines, and for centuries, constipation has been treated with different fresh and dried fruits, berries, beans, whole grains, nuts, and

seeds. An example of the other effect, the activation of the limbs, can be found in grains, especially oats, as reflected in the old German saying 'vom Hafer gestocken'. This literally means 'stung by oats'. In earlier times, in Central Europe, when the farmers depended on work horses, it was well-known that when the horses needed to work hard, there was nothing as good as oat flakes for activating their full strength. From the nutrient composition of oats *(Avena sativa)*, we get a first impression of their ability to activate the limbs and muscles of

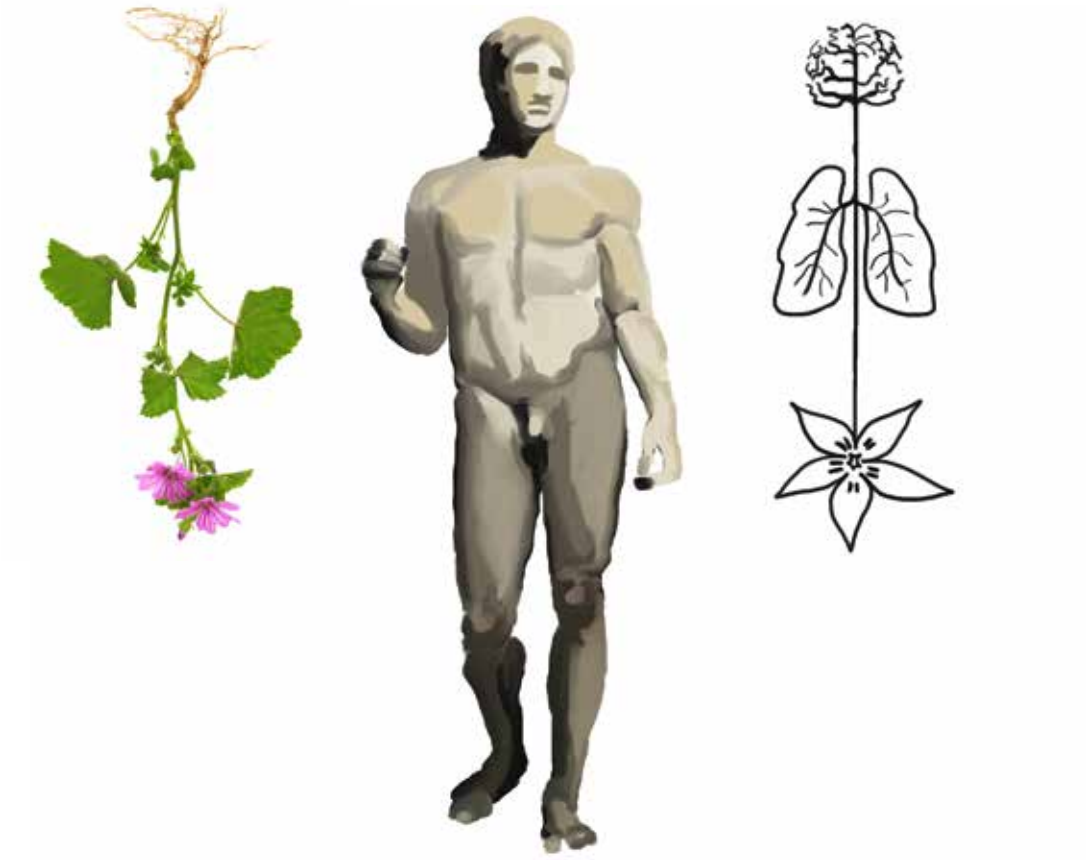

***Figure 6**: The correspondences between the three functional systems of the human being, and the plant organs. Here, the plant root organs have a stimulating effect on the human nerves-and-senses system; the plant leaf and leaves have a supportive effect on the rhythmic system - the blood circulation and the lung activity; and fruits and seeds have an activating effect on the limb-metabolic system.*

both horses and humans: oats contain a high percentage of protein which is rich in essential amino acids; oats are rich in fibres, including specific carbohydrates which stabilise the blood sugar level as well as the blood cholesterol level; oats contain high-quality fats with an optimal low ratio of Omega-6 to Omega-3; oats are rich in the water-soluble vitamin B, which plays a key role in the transmission of stimuli in the nervous system; and oats are rich in iron, which is a component of the red blood pigment haemoglobin, which transports oxygen in the blood.

Steiner stated that the correspondence between fruits/seeds and, on the other hand, our digestion and the activation of our limbs, can be taken further, whereby the three functional systems of the human are connected to the different plant organs. Thus, the root organs of plants have a general, supportive effect on the human nerves-and-senses system, while the stem and the leaves have a supportive effect on the rhythmic system. And, as we saw, the fruits and seeds affect the limb-metabolic system. See figure 6 opposite for an illustration of the three human systems, the uptake of earthly and cosmic substances, respectively, and the three major plant organs.

Formation of proteins and enzymes based on 'blueprints'

According to natural science, as humans we are not able to build proteins and enzymes all by ourselves, as plants can. From our diet we must have a continuous supply of essential amino acids which our body cannot produce itself. Here, Steiner stated that our body has no memory for building proteins. Thus, we continuously need 'blueprints' for protein and enzyme formation, from the proteins and enzymes in our foods. During the digestive process, our body obtains 'blueprints' from the vegetables, fruit, and grains that we eat.

As described earlier, the protein is 'the real body of the plant', meaning that the etheric body of the plant is especially active through its proteins and enzymes. In the human being, the etheric body does not work on its own, but is continuously 'instructed' by the astral body, which again is instructed by the I organisation. Here, our spiritual bodies all need specific proteins and enzymes to be active. We can assume that only when the plant has completed its fruit formation, will the necessary protein and enzyme 'blueprints' be available.

Bringing the pieces together

Let us now try to bring together the two aspects, the re-building of the bridge between our thinking and will to action, and the plant reaching its fruit formation.

The nerves-and-senses system is built from the foods we eat, from 'earthly substances'. Besides minerals, carbohydrates, vitamins etc., we need optimal fatty acids and proteins. Optimal fatty acids are needed not least for the child to develop an optimal basis for its cognitive and memory processes. We primarily get such fatty acids from plants and milk. A long-term intake of non-valuable fatty acids, will lead to a reduced plasticity of brain cells, resulting in a less efficient brain function. For the brain and nerves-and-senses system to work, we need optimal proteins. When the brain is inactive, it only uses glucose. However, when we engage in memory and cognitive processes, we need proteins, or more specifically, we need specific amino acids in order to build the signal compounds which are active in the communication between the brain cells.

In order to build the limb-metabolic system we need condensed 'cosmic substances'. For the condensing of these substances, we need the craftsmen of the etheric body, the enzymes. To build these enzymes, we can assume that we need fruit proteins as 'blueprints'.[42] When speaking of fruits, bear in mind that we get fruit proteins from the fruit organs of root, leaf, fruit, and seed crops. And for the activation of the limbs, the muscles, and the digestive system, we need the fruit/seed organs of plants.

To rebuild the bridge between our thinking and will, we must use the right plant varieties; we must fertilise the crops with high-quality compost and stimulate the plants by means of biodynamic preparations. When nature's seasons and climate are suited to the needs of the plant, then the plant will manifest optimal fruit formation and ripeness. Our nerves-and-senses system can then be built and function in the right manner, and the limb-metabolic system can be built in the right manner, based not least on optimal fruit proteins. These proteins serve not least as blueprints for the enzymes needed by our spiritual bodies in order to work. When we get the necessary whole grains for activating our digestion and our limbs, we can set our muscles in action.

Finally, we can assume that we need a stimulus of I forces from our foods, to assist in integrating the activity of our four bodies, as well as our three functional systems. During photosynthesis, the plant absorbs etheric and higher

forces together with physical light photons, and on the other hand the plant takes up I forces from the cow manure and compost via the soil. As humans, we can absorb some forces from the sunlight, for example a small uptake of sunlight through the skin, as a basis for producing vitamin D. In contrast to this, the plant can fully absorb the forces from the sunlight, and from the soil. As described earlier, since the cow is a herd animal, it does not have an incarnated, individual I. Instead, the cow herd shares a group soul which corresponds to the human I. The forces connected to this group soul are partly left in the manure as 'a nascent I force' which is taken up by the plant via the compost. Then, the human takes it up from the plant. Hereby, the nutritional impulse offered by Steiner has reached its immediate goal.

Food quality and food culture

Nutrition is about nutrients and vitality, and about stimulating all the levels of our being, including the physical, physiological, emotional, and spiritual levels. Further, nutrition is about preparing the components of the meal in the right way, and about sharing the meal in a social context. All these aspects are important for our digestion, health, and well-being.

An optimal meal starts with high-quality raw materials, from which a mainly plant-based healthy meal is prepared. The raw materials and ingredients should preferably come from biodynamic farms. Local foods should be preferred, not least in order to support the farmers and gardeners in the region, and to reduce unnecessary transport. In a best-case scenario, after the farmer has laid down much effort in supplying nutritious vegetables, fruit, and grains, the cook will carefully work with the quality of the raw materials. Excessive heating is avoided, and the elements of the meal are preferably made freshly.

Preparing meals includes taking into consideration the three-fold plant in its correspondence to the three-fold human. A primarily plant-based diet should include ordinary vegetables and spices, as well as medicinal plants, whereby a broad spectrum of nutritional and health impulses are offered for body, soul, and spirit. Finally, the whole atmosphere around the meal should support the meal as a social and spiritual event. A verse or a prayer will in most cases be helpful in creating such a beneficial atmosphere which works all the way into the digestion. In addition, recurring meal rhythms are helpful for both the cook and those participating in the meal. For a more detailed presentation of

a food culture that is based on a spiritual scientific view of the human, see [43].

Unfortunately, the modern Western European way of life is increasingly undermining these aspects of a meal, including the meal as a social event. The number of industrially prepared 'to-go' meals is rapidly increasing, as in the habitual activation of electronic devices during meals.

Sub-nature forces and our foods

It is essential that the fatty acids and proteins in our diet are not 'denatured' by heating or other types of processing, whereby etheric and higher forces can no longer be active. The ever-increasing industrial processing of foods has weakened the nutritional value of our foods, such as we saw for milk when pasteurised. Here, oat flakes represent an example of how industrial processing can destroy the quality which the farmer has carefully created.

In oat kernels we find the enzyme lipase. It is dormant and passive when the kernels are intact. But when the kernels are made into flakes, this enzyme is immediately activated and starts to break down the valuable fatty acids of the kernels, and within a few weeks at room temperature an undesired rancid smell will develop. To prevent this enzymatic process, the flakes are treated with high-temperature vapour to wet the flakes, followed by drying by means of high-temperature dry air, far above 100°C. This treatment inactivates the etheric forces of the enzyme, resulting in a loss of nutritional value.

During the Agriculture Course, Steiner was asked if it is permissible to preserve foods using electric currents. His answer was that electricity affects the nerves-and-senses system of both man and animal, and correspondingly, it affects the root organ of plants. If we eat foods which have been exposed to electricity, we will slowly develop sclerotic diseases, and our life span will be reduced. Electricity is at a lower level than that of living organisms and will inevitably cause damage to these. [44] On other occasions, Steiner spoke of 'sub-nature forces', including electricity, magnetism, and nuclear forces. These forces have a natural role to play in nature; however, when taken out of context they become harmful. More specifically, they are 'condensed' etheric forces. Electricity is a condensed state of etheric forces which were originally connected to sunlight.

In natural science it was believed for decades that undesired health effects

from electromagnetic radiation are found only in connection with the so-called ionising X-rays and gamma-rays. Today, we know that long-term exposure to non-ionising radio waves can have harmful effects on living organisms. The most disputed area is that of harmful effects from non-ionising microwave radiation from mobile phones. When plants are exposed to mobile phone radiation, the effects can be significant biomass reduction, a decrease in leaf photosynthesis, and an extensive deformation of chloroplasts. [45]

Today, the Codex Alimentarius represents a collection of standards, guidelines, and codes of practice, established by FAO and WHO to protect consumer health and to promote fair practices in food trade. According to this codex, the irradiation of foods up to 10 kGy will not result in toxic or undesired nutritional effects. Consequently, in the conventional processing industry, foods such as wheat flour, wheat, rice, maize, fruit, vegetables, pig meat, chicken meat, fish, spices, dried fungi, and seafood can be irradiated without labelling this. It is argued that harmful microorganisms are reduced or eliminated, whereby the nutritional value remains intact. But it has been shown that 5-80% of vitamins can be lost, and toxic compounds can be generated in various foods. Further, a biodynamic researcher showed rhythmic changes in the size and shape of various tree buds which are connected to planetary rhythms and constellations. Here, it was found that trees growing close to an electricity sub-station with high-voltage cables and transformers, did not respond to specific planetary rhythms in the same way as trees growing further away from the sub-station. [46]

It may seem surprising that Steiner was asked about electric currents for preserving foods, but already in the 1880s, physicists experimented with plants growing under electrical cables, to 'stimulate the plants by atmospheric electricity'. Some studies showed higher yields for carrots and peas, but due to the lack of convincing, systematic effects, this 'electroculture' did not gain any permanent position. In the 1980s, Chinese researchers placed electrical cables above plants, raising the natural vertical voltage of 100 V/m to 700–20,000 V/m. In addition, in a modified procedure, electrodes were placed directly in the soil, whereby electrical currents ran directly through the plants, and when touching a plant, one got a small electric shock. Today, research in this area is increasing. [47]

Anthroposophic medicine

This medicine was first developed in the 1920s by Steiner and the Dutch physician Ita Wegman. By not focusing on isolated symptoms, it represents a salutogenic approach to health. It concerns physical, psychological, and spiritual health, as well as the impact of a person's environment and social life. [48]

In the spiritual scientific view of the human being, health is seen as depending on the vitality and regeneration ability of the etheric body, on the emotional and instinctual processes carried out by the astral body, and on the capacity for individual thinking and sense of self, carried out by the I organisation. In addition to this, the self-healing capacity of the soul and spirit is equally important. The doctor-patient dialogue and relationship is emphasised, and the therapeutic approach includes not only the physical health and symptoms of disease or injury, but additionally the patient's biographical data, personal history, emotional state, mental health, overall well-being, and spiritual health.

Anthroposophic medical therapies are primarily found in Europe. The German Medicine Act of 1976 legally recognises anthroposophic medicine as a therapy system. Similar steps have been taken in other countries, including Switzerland and Brazil. Since 2000, anthroposophic medicine has been met with greater interest in clinical practice as well as in scientific research, in connection with the establishment of the scientific discipline 'complementary medicine'. In the WHO Traditional Medicine Strategy 2014-2023, traditional, complementary, and integrative medical therapies, including anthroposophic medicine, are seen as part of health-care strategies worldwide. [49]

Anthroposophic medical doctors are qualified physicians who have received additional training to integrate anthroposophic medicine into their conventional practices. The diagnostic practice includes not only physical symptoms – such as a severe infection – but also lifestyle factors, such as poor nutrition or high stress, which can promote and prolong the physical symptoms. Factors such as personal history, age, and other environmental or social factors will influence a person's overall health, and as such they are part of the medical diagnosis. Based on such a comprehensive assessment, a combination of conventional and anthroposophic medicines and therapeutic treatments is chosen, suited to the individual's particular needs. [50] Generally, these treatments will include one or more homeopathic preparations, based on the overall pattern of

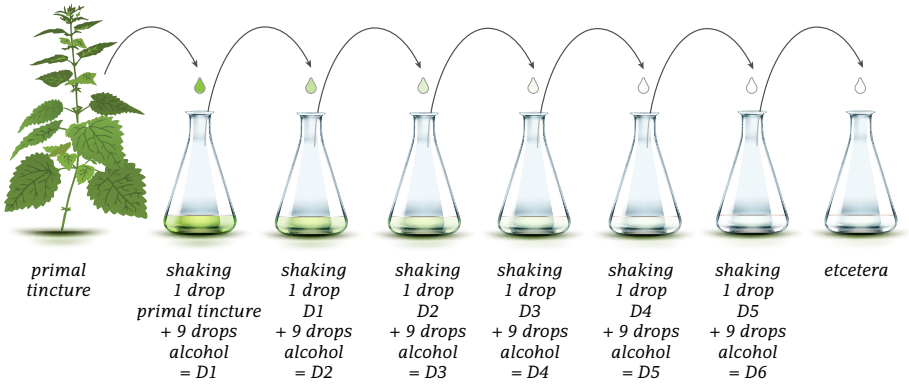

***Figure 7**: Illustration of the stepwise production of a decimal, potencised, homeopathic preparation: From an original watery solution of 1 liter, 1 deciliter is transferred to a suitable flask; 9 deciliters of distilled water are added; and the solution is succussed in an effective, rhythmic manner. Hereby, a D1 homeopathic preparation is available. By repeating this procedure, a D2 preparation is available; and so on.*

symptoms. The word *homeopathy* itself is composed of the Greek words *homoi-os*, meaning 'similar' and *pathos* 'disease', and denotes treatment with a drug that gives symptoms similar to those seen in those suffering from the disease. The preparations are produced based on a so-called potencising process. In a widely used form of potencising you take 10 percent of the original substance/juice/solution, dissolve it in 90 percent water, and shake the new solution in a specific manner to ensure thorough 'succussion'. Hereby you get a D1 potency. This process can be repeated any number of times, for example to reach D12, D30 and higher potencies and higher potencies, see Figure 7 above. Additionally, it is possible to use ethanol or lactose for potencising.

Homeopathic therapists routinely use D30 potencies, which is the reason why many medical scientists reject homeopathic preparations. Theoretically, a D30 potency contains no molecules from the original substance/juice/solution after a 30-fold succussion. However, several studies have been published documenting the effects of homeopathic high potencies on cancer and other diseases. [51] Preliminary studies indicate that the water structure of homeopathic D30 potencies is different from the structure of untreated water, while other studies indicate that these water structures can be stable. [52]

In some areas of Germany, France, England, and Switzerland, homeopathy is so widespread that it is perceived as an integral part of the national health

system. According to WHO, an estimated 400 million people worldwide use homeopathy as a primary treatment. The rejection of homeopathy from the side of 'conventional' medical doctors will undoubtedly continue but will gradually be reduced as the phenomenon of stable water structures becomes more documented. For an overview of homeopathic research including plant and animal models, respectively, see [53,54].

Homeopathic veterinary medicine has a long history of being used to treat mastitis in milk cows. This udder infection is closely linked to a high milk yield. Generally, on conventional dairy farms, homeopathic treatments are not optimal, and instead antibiotics are used. [55] As opposed to this, biodynamic cows with a more balanced physiology and milk yield will have a low occurrence of mastitis. By means of close monitoring of the cows, in combination with quick intervention in response to signs of illness, biodynamic farmers can in most cases replace antibiotics with homeopathic preparations. During a study a biodynamic dairy farm with 300 cows was able to reduce the number of antibiotic treatments by 75%, as compared to the number of mastitis cases which would typically be treated with antibiotics under conventional conditions. [55]

Food quality – a complex matter

Food quality is about more than the minerals, carbohydrates, fats, proteins, fibres, and vitamins which are listed on the supermarket product labels. We do get relevant information from these labels, but vegetables, fruit, and grains are living organisms, and we must perceive, grow, and examine them accordingly.

When comparing conventional and biodynamic agriculture, we notice a striking polarity. Aquaponic production systems are arguably the most extreme example of conventional agriculture. In aquaponic production systems plants are perceived and managed as isolated organisms to which specific physical conditions (light, CO_2, warmth, humidity, and water), and roughly 20 different inorganic nutrients must be supplied. The plants grow in a monoculture, separate from any other microorganisms and ecosystems.

On the other hand, on biodynamic farms the plants are perceived and managed as sentient organisms, with deep roots into both the soil and the sky, with physical and spiritual bodies which are affected by the sun, the planetary

world, and the stellar universe. The farmer can work with the planetary forces promoting growth and reproduction, and at the same time, with planetary forces promoting the formation of nutritional fruit tissue. Already in the soil, the plant is confronted with an unimaginable abundance of microorganisms and other living organisms: it develops symbiotic relations to fungi at its roots, and its leaves will be covered with microorganisms, of which some will end up renewing the microflora in our intestines.

The saying 'A healthy soil gives healthy plants which give healthy animals and humans' was originally coined by organic agriculture pioneers. It summarises the overall challenge faced by the farmer: make the farm soils ever more fertile, manage a balanced animal husbandry, take care of biotopes and perennial tree areas, and integrate the farm into the surrounding landscape. The farmer is not a manager of an industrial production; instead, he/she is orchestrating a farm organism, an individual farm entity. The farmer has at his/her disposal the biodynamic field and compost preparations which can stimulate plant growth and the uptake of nutrients and forces from the soil and the atmosphere, with the goal of reaching an optimal fruit formation stage. Based on a spiritual ABC of plant growth, encompassing physical, etheric, astral, and higher forces, the farmer can bring forth crops which are nutritious for the body, soul, and spirit.

When the plant has reached its fruit formation, be it a 'root fruit' such as a carrot, or a 'fruit fruit' such as an apple, it will have a desired maximum of vitamins, health-promoting secondary compounds, and activity of spiritual forces. The plant will have valuable fatty acids, as well as proteins which can serve as blueprints for the proteins and enzymes needed not least by the etheric body. Hereby, we can build our nerves-and-senses system, and we can build our limb-metabolic system. Finally, optimal wholegrains, fruits, and seeds can activate our limb-metabolic system, whereby we as humans can reconnect our thinking and our will for action. We can be active in our personal lives, as well as in society. We can set up and implement personal goals as well as goals for the benefit of the society and culture in which we live.

So, does this mean that biodynamic agriculture has manifested its full potential, and that we cannot expect a further development in the quality of biodynamic foods and products? No, this is by far not the case, for more reasons. Let us take three examples of how this quality will undoubtedly improve over the coming decades.

The continuous breeding of new vegetable and grain varieties, based on a cooperation between breeders, farmers, and researchers, will no doubt bring forth new varieties with potent health-promoting, 'bio-regulative' properties.

The second example concerns something which Steiner did not point to during the Agriculture Course, but instead during private conversations which were later published in various ways. Here, Steiner pointed to the importance of the interaction between specific crops and neighbouring plants. Thus, a potato crop should be complemented with horseradish growing around the field, and esparsette and cornflower should grow together with grain crops. This way the nutritional value of specific crops can be improved. Steiner pointed to these measures as an integral part of manuring, and we can expect that these and additional measures will gradually be implemented as an integral part of biodynamic agriculture. [57]

Finally, let us take something which from the political side will have a positive effect on the possibility of biodynamic farmers to work with the quality: the recent change in EU's common agriculture policy (CAP). In June 2021, a new 'farm to fork' strategy was agreed on which will be effective until 2028. This strategy represents a major shift in the agriculture policy, moving away from prioritising and subsidising large, industrial, conventional farms, towards binding environmental and climatic objectives for the individual farm, including protection of ecosystems, biodiversity, ground water resources, and animal welfare. [58]

Here, the open question is in which way the strategy will be implemented in the individual EU-countries, thereby offering organic and biodynamic farmers better conditions for improving farm practices and ultimately the crop and product quality. Clearly, the new policy states that the present conventional agricultural practices are not sustainable. Over the last decades, several scientific reports have documented and highlighted this lack of sustainability. Recently, an English report has pointed to serious public health risks connected to the use of pesticides. The report was intended for the British government, which after leaving EU must elaborate new regulations on pesticides. [59] Also, a recent media report, based on testimonies from earlier employees of the US Environmental Protection Agency (EPA), has documented that EPA has approved numerous pesticides for application, despite toxicological test indicating health risks connected to the individual pesticides, heavy pressure from pesticide pro-

ducers and politicians. [60] The open question is if indeed this new EU policy represents a major showdown with conventional agriculture as we know it today, paving the way for truly more sustainable agricultural practices.

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Perspectives for biodynamic agriculture

6

In this final chapter, we shall see that fertile soil is now high on the international political agenda; we shall see how the experienced biodynamic farmer can meet the challenge of developing the farm organism as the basis for food quality; we shall see how the farmer can meet recurring economic challenges; and we shall point to the anthroposophical movement in which biodynamic agriculture is embedded.

Paradigm shift in political agendas

The American scientist Thomas Kuhn (1922-1996) introduced the concept of a paradigm shift. A paradigm is an overall view of the world, its structure and development, and of the human being. The birth of science in the Renaissance represented a huge paradigm shift whereby the ruling Catholic Church and its religious dogma had to step back and give way to the scientific paradigm. The Pope has since stated that the Church was wrong to condemn Galileo Galilei, one of the fathers of natural science, to death for heresy. The death sentence was not carried out; instead Galilei spent the rest of his life under house arrest. Today, the term paradigm shift is also used to describe a major shift in political and social views. [1]

The living soil on the political agenda

When the immigrants crossed the American prairie lands in the 19th century, they found abundantly rich humus soils, with 300-400 different plants species and millions of grazing buffaloes. Such soils represent an optimal basis for agriculture. However, since the Second World War, these lands have been under heavy pressure from intensive, conventional cultivation systems, resulting in a critical reduction in the soil humus content. When replacing a balanced crop rotation with humus-consuming cash crops, humus carbon structures will inevitably be broken down. Today these prairie lands contain only a minimum amount of humus.

Since the 1960s, the representatives of global conventional agriculture have argued that only this approach to agriculture can feed the world. However, this argument is now crumbling at the highest political levels. In 2013, UNCTAD, the UN Trade and Development Organization, held a major conference on the future of global agriculture. The conclusions and recommendations of the 60 participating experts were clear: a paradigm shift in global agriculture is needed, with a rapid shift away from agriculture based on a high level of external inputs. This type of agriculture is slowly eroding nature's ecosystems and energy reserves. A conversion is needed towards a broad spectrum of agroecological farming methods, adapted to local conditions and resources. [2]

In 2011, an EU report based on research conducted by 11 universities and research institutes, concluded that intensive cultivation systems result in loss

of biodiversity, including soil biodiversity. Subsequently, the EU Commission implemented a strategy for reversing this development; however, in 2020, the European Court of Auditors concluded that no major effect of the strategy could be found. [3]

In 2020, the EU Commission launched an ambitious strategy called 'From Farm to Fork' as part of a renewal of the common agricultural policy (CAP). The strategy included increased requirements for 'Good Agricultural Practice', imposing a major restraint on conventional nutrient inputs, and requiring the recycling of nutrients from cities on farms. The goal is a rapid reduction in the undesired impact of intensive cultivation systems on the soil, the environment, and the climate. The strategy has triggered a fierce political fight over the EU agricultural budget of 400 billion euro. So far, a major part of the budget has been distributed as passive hectare subsidies, ending up not least on large conventional farms which contribute to soil erosion as well as undesired environmental and climate footprints.

Building up soil fertility

Today, it is well-documented that organic cultivation systems can regenerate eroded soil. [4] But does biodynamic agriculture have a unique role to play in this context? The answer is 'yes'. The Egyptian community Sekem has shown that desert sand can be converted into fertile soil over a few decades. Further, the comparative DOC trial has shown that the only cultivation system which increased the soil humus content was the biodynamic one, based on a high level of compost. The humus content of the organic plots was relatively stable, while the content of the conventional plots slowly declined since the launch of the project in 1978. In short, the biodynamic plots showed the highest organic carbon deposits, the highest soil microbial diversity, and the lowest nitrous oxide emissions (N_2O). [5]

The international Demeter regulations state that a minimum of 10% of the farm area must be rich in biodiversity. Since 2017, the US Demeter Association has performed soil tests to examine the soil carbon deposits and the carbon sequestration on individual biodynamic farms. When an inspector makes the annual visit to the biodynamic farm, soil samples are collected and sent to a lab for testing. Within relatively few years, these test results will accumulate into a real-life documentation of to what extent biodynamic agriculture se-

questers carbon in the soil, as an alternative to the soil degradation caused by intensive, conventional cultivation systems. [6]

In 2021, out of 19 applicants from nine countries, the European Landowners' Organization (ELO) awarded a Slovenian biodynamic farmer the International Land and Soil Management Award. This award is intended for exceptional examples of soil management practices which can mitigate soil degradation, erosion, reduction of soil organic matter and biodiversity, and soil contamination, compaction, salinisation, and flooding. The European Commissioner for Environment, Oceans and Fisheries, who presented the award, stated the importance of soil protection in ensuring food security and biodiversity, and the importance of common action to reduce the impact on climate change. The president of the expert jury, a soil scientist from the University of Vienna, stated that the jury was particularly impressed by the description of the regeneration of soil which had been severely damaged by construction works. [7]

The Slovenian farmer has practised organic farming since 2003. In 2014, the farm was converted to biodynamic farming. The farmer stopped ploughing the arable soils more than 10 years ago, replacing this practice with rippers and subsoilers for conservation tillage. Today, the fields are fertilised with biodynamic compost made from farmyard manure. The biodynamic preparations are applied relatively intensely, and biodiverse green manure mixtures are used, increasing the soil organic matter.

The health circle

The saying 'A healthy soil gives healthy plants which give healthy animals and humans' gives an immediate impression of a chain. However, we should instead speak of a health circle, a circle which can only be built when both the animal manure and green kitchen waste are returned to the fields. Today, large-scale composting plants are available; however, it will be a huge task to implement these techniques on a global scale. [8] Figure 1 below illustrates the health circle.

In the 1950s, Pfeiffer, Steiner's close co-worker, moved to the US. Here, he directed a municipal composting program in Oakland, California, in which green household waste was composted and subsequently pelletised for use as

***Figure 1**. The health circle, from soil to plant to animals/humans and back again, based on plant residues, animal manure, and green kitchen waste being composted and returned to the farm soil.*

agricultural fertiliser. He designed a 'compost starter' for industrial and urban waste, which included biodynamic preparations (500, 502-507), as well as various bacteria, fungi, and yeasts. The composting was designed for converting large quantities of green waste into stable compost via a quick, hot compost fermentation. [9]

The farmer's eye

In conventional agriculture, the handing down of experience from farmer to farmer over generations has been replaced by a top-down extension system in which the farmer is no longer the centre of observation, decision, and action. In contrast to this, the biodynamic farmer is challenged to sense, understand, and develop the farm organism into an individual farm, as the basis for producing optimal foods. Here, the farmer has a task similar to that of the conductor of a symphony orchestra. If the brass section plays too loudly, it must be quietened a little, and if the violinists cannot bring forth the necessary mood, they must be encouraged to do so. The farmer must sense the potential of the given natural conditions and work out a balanced crop rotation and animal husbandry, and he/she must care for various types of biotopes and biodiverse areas on the farm. Further, the farmer is challenged to work with biodynamic preparations as a means of influencing the activity of etheric, astral, and higher forces in and around the farm.

All this may give the impression that a biodynamic farmer must be clairvoyant to fully meet the challenge of farming biodynamically. However, this is by no means the case. During the Agricultural Course, Steiner emphasised that the farmer should build a personal relation to everything on the farm, especially to the handling of the manure. This personal relation builds up a susceptibility to the subtle spiritual processes which take place on the farm. Steiner stated that the learned scholar will easily misjudge the importance of the farmer walking over the fields at the end of the day. The farmer can develop a meditative method, 'a method of spiritual perception'; however, the experiences of the farmer may not be easy to describe and express in words. [10]

The experienced biodynamic farmer builds up a 'tacit knowledge' based on a long-term, intimate experience with the complexity of the individual farm. This complexity is not easily verbalised and transferred to other persons, unlike the instructions for using a given pesticide to eliminate a given insect. Out of this tacit knowledge emerges an ability to do the right thing at the right time.

Here, we can speak of the farmer's eye, just as we speak of the breeder's eye, enabling the breeder to select the necessary few, right plants among literally thousands of plants. Likewise, we speak of the doctor's clinical eye, observing small details concerning the patient's condition which the less experienced

colleague will not notice. Often, these details will provide a deeper understanding of the patient's condition, leading to the right diagnosis and subsequent treatment.

The experienced farmer exercises what can be termed experience-based research, as opposed to the evidence-based research which is taught at universities. The goal of the farmer's research is to find methods that work within the reality of a specific, individual farm. This fact does not diminish the value of the contributions of the researcher and the extension person. Indeed, a true cooperation can develop between the farmer, the researcher, and the extension person. The 'study object' of all three partners is the whole farm, and the research process is based on an ongoing dialogue between the three partners. Hereby, new experiences and practices can be developed which will be helpful to all partners. [11]

As we have seen, in general, biodynamic crops and foods have the potential for optimal fruit formation and ripening. To fully unfold this potential, the farmer needs fertile soil and open-pollinating varieties, and needs to use biodynamic preparations and to care for the farm as a balanced organism, including not

least a mixed husbandry. In this context, the farmer's eye is essential. When the farmer develops a deep connection to a cow herd, he/she will find the answers to the following questions: Is the present race suited to the landscape, the climate, and the vision for the farm? Which properties and characteristics should be prioritised or downgraded? What are the qualities and shortcomings of the individual cow? Does it have a harmonious body? Does it remain healthy and robust, despite a change in the fodder, a serious change of weather, or an undesired disruption to its daily rhythm? Does it give a suitable milk yield over a longer lactation period, based on roughage and fodder from the farm? Does it have a history of recurring mastitis? Does it have a good temperament? Does it care for the calf in a good manner? Does it eat well in the field, thereby setting an example for the younger cows? Last, but not least, if the farm has a bull of its own, what are the properties and characteristics which should be prioritised for the herd?

The ability to produce a suitable amount of milk, based on a strong ability to digest roughage – fresh grass and clover, hay, silage, etc. – is highly valuable. Here, experienced biodynamic farmers have observed that, in parallel to the gradual development of a balanced farm organism, the cows need less fodder to produce the same amount of milk. During this process, the cows will improve their ability to avoid large fluctuations in milk yield when moved to another field or given a new batch of fodder. A herd of cows with a suitable milk yield, together with a low occurrence of mastitis, is a good indicator of a balanced farm organism. By means of careful attention to the cows, together with quick intervention in response to early signs of illness, the farmer will in most cases be able to replace antibiotics with homeopathic preparations in case of mastitis. In contrast, on conventional dairy farms, this disease is treated with antibiotics.

All in all, animal breeding is not only a process of bringing desired parent genes from one generation to the next. The cow will actively adapt its whole physiology and digestion to the individual farm conditions. Today, the scientific discipline of epigenetics has documented that living organisms can indeed acquire new, stable properties during their lifetime which are passed on to the next generation via altered genes. This growing scientific understanding of animal development has been present in biodynamic agriculture from the very beginning.

The farmer, the consumer, and the round table

A recurring challenge for both organic and biodynamic farmers is the economic basis of the farm. Today, the majority of consumers choose cheap foods and products. In Europe, the percentage of income spent on food has steadily decreased over the last 50 years. A report from 2016 showed that eight countries in the world spend less than 10% of their household income on food, including England, Switzerland, Ireland, and Austria, spending 8.2, 8.7, 9.6 and 9.9%, respectively. The lowest percentage was found in the US, constituting only 6.4%. [12]

This process reflects the ever-increasing industrialisation and productivity of conventional agriculture, as well as the substantial subsidies allocated to conventional farms, resulting in lower food prices. In the supermarket, when the consumer compares the prices of conventional, organic, and biodynamic foods, this fact is hidden. Further, undesired environmental and climate change effects from conventional production systems are also hidden, including CO_2 emissions from the farm, as well as those connected to the production of inorganic fertilisers, fossil fuels, and pesticides.

As part of the above-mentioned paradigm shift, various economic models for 'true cost accounting' have been developed which can calculate these hidden costs. The models include a pricing of direct and indirect CO_2 emissions, together with positive and negative sustainability indicators, such as emissions of other greenhouse gases, carbon sequestration in the soil, biodiversity, and the use of fossil fuels and other external inputs. In the EU, these models can be used to regulate the agricultural subsidies for individual farms according to an overall principle of 'the polluter pays'. If these models are indeed introduced, the prices of conventional foods and products will go up markedly, relative to organic and biodynamic ones.

But even with the hidden costs of conventional production systems included in the accounting, a more fundamental challenge remains hidden. The present focus on globalisation and the world market hides the fact that you cannot fairly apply the same economic thinking to agriculture and industry. The advanced industrialisation of conventional agriculture gives the immediate impression that this is indeed possible; however, fundamental differences are overlooked. In industry, you can decide that within three years a five percent reduction in costs shall be implemented, based on an optimised production

setup, digitalisation, as well as the introduction of robots for specific operations. However, national parliaments cannot decide that within three years a five percent reduction in the pregnancy duration of women will be implemented as a contribution to increased productivity elsewhere in society. Biology and industry are two very different things. In agriculture, when treating the 'means of production' – healthy soil, plants, and animals – as isolated production units, hidden health and environmental costs will inevitably accumulate.

The biodynamic farmer has various possibilities to meet the economic challenge imposed on the farm by competition from cheap conventional foods. Many biodynamic farms have a farm shop which sells foods and products which have been processed on the farm. Hereby, an additional income is generated, based on bread, milk, and meat products. But what is more, experience has shown that such a shop brings recurring, inspiring meetings with customers, and that some of these will at some point take a committed step forwards by offering their manual help during busy periods, helping organise recurring cultural events and seasonal celebrations, and much more.

In the US, there are more than 15,000 so-called community-supported farms – CSA-farms – which work together with consumers who have organised themselves in various more or less formal ways. The term CSA is used quite broadly, ranging from a farm delivering a once-a-week box full of local foods to the customer's door, to legal constructions whereby a consumer association buys machinery or even cows from the farmer and leases them back on favourable conditions. Hereby, capital is made available to the farmer for whatever is needed to promote the development of the farm. [13]

We speak of 'fair trade' when farmers from the Third World are paid market price plus an add-on by consumers in Western countries. Hereby, communities of farmers are helped towards a decent life, enabling the communities to buy processing facilities and to build schools, etc. The important point in connection with biodynamic farms is that the consumers step out of a passive consumer position and take practical and economic co-responsibility for the food which the farm supplies. As a result, fair trade arises, based on the shared responsibility of the farmer and the consumer. In a wider perspective, the challenge is to establish a round table including four equal partners – the farmer, the processor, the wholesaler, and the consumer. In the Demeter organisations these partners work to-

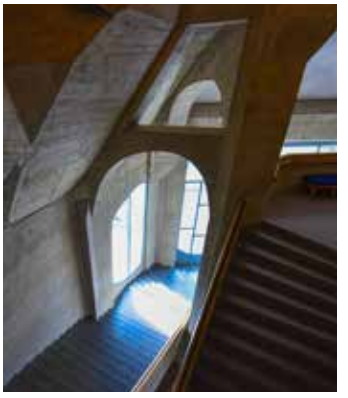
gether. Ultimately, the farmer will thus be freed to focus on the essential task of bringing forth healthy foods for the human body, soul, and spirit.

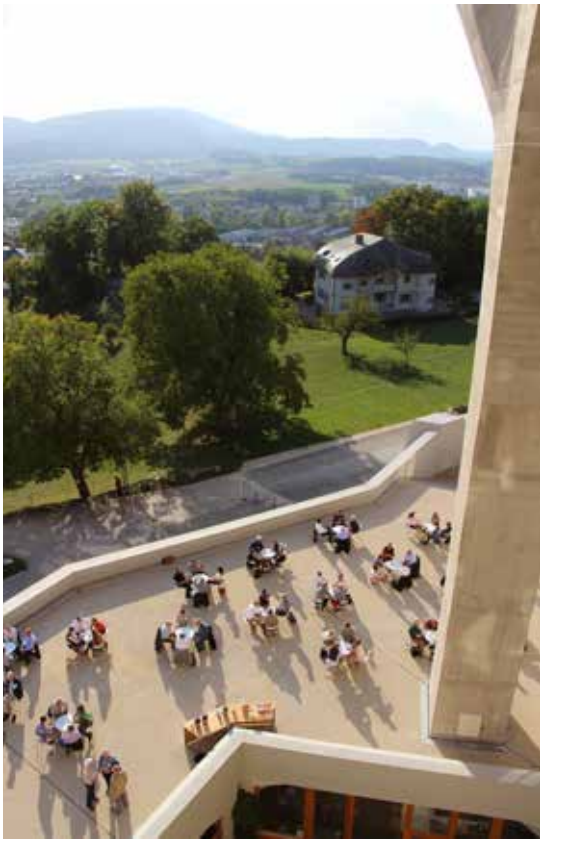
Numerous biodynamic, agricultural communities can be found around the world. These range from extended families to communities with more than 100 people. One such large community is Dottenfelderhof, located a few kilometres from Frankfurt Main in Hessen, Germany. The community illustrates the abundance of agricultural and cultural activities which can be generated when people join forces. The 190ha agriculture area has been managed biodynamically since 1968, including roughly 40 hectares of grassland available for 80 dairy cows. The farm activities include fruit and vegetable growing, and raising poultry, pigs, sheep, geese, horses, and bees. The milk is processed into various dairy products, and the grains are processed into various breads, rolls, and pastries in a wood-fired bakery. The farm's own products are sold in two farm shops and at local markets. A broad spectrum of cultural activities take place at the farm, including the Agriculture School Dottenfelderhof, offering a formal education in biodynamic agriculture, including both basic and more advanced courses. In addition, research and the breeding of biodynamic seeds take place there. [14]

Biodynamic agriculture and anthroposophy

Steiner described anthroposophy – 'wisdom of the human being' – as a path of knowledge, a science based on spiritual observation, intended to guide the spiritual in the human being to the spiritual in the universe. Numerous people from all walks of life came to ask Steiner for advice, guidance, and inspiration. Today, anthroposophically inspired activities can be found in teaching, medicine, therapies, nutrition, pharmacy, economics, banking, social renewal, organisational development, community building, various arts, performance arts, and more.

Thus, the Waldorf educational system and the Steiner schools are based on a spiritual view of human development, specifically the three 7-year stages of childhood and youth. The guiding principle is the harmonious development of the three soul functions: will, feeling, and thinking. For the pre-school child, will and physical action are predominant. Between ages seven and fourteen, the emotional development is predominant, and, from fourteen to twenty-one,





the development of an objective, free way of thinking is predominant. Further, the curriculum of Waldorf schools includes a broad range of practical artistic activities, which balance and harmonise the development of the child and young person.

In the medieval period, natural science inaugurated a paradigm shift from a culture dominated by the Catholic Church, towards a secular culture, free of dogma and superstition. As compared to this, Steiner's impulses represent a fundamental shift towards a culture based on a genuine spiritual science. He had no expectations that such a shift towards a spiritualised culture would take place in any near future. However, this shift must be prepared in numerous ways.

As mentioned earlier, Steiner provided detailed descriptions of how to develop the necessary spiritual insight, and he consistently encouraged people not to build on unconscious revelations, dreams, hypnosis, and mediumship. Knowledge of the spiritual world should be developed in full awareness from the I, the centre of the human. He repeatedly described the gradual evolution of human thinking during earlier cultures, and the parallel shrinking of the 'old' clairvoyant ability into an unreliable, atavistic access to the spiritual world which must be developed anew.

Today, many biodynamic farms cooperate with some of the above-mentioned, anthroposophical activities, be it by receiving children from a Waldorf school to experience at first hand the activities on a farm, by offering a protected work situation for persons with disabilities from anthroposophical institutions, or in other ways.

In 1923, on Steiner's initiative, the present General Anthroposophical Society was established, together with the present School of Spiritual Science. The latter is intended for members of the Society who wish to devote themselves to a focused schooling of their spiritual perception. The above-mentioned spectrum of anthroposophical activities is inspired and coordinated, when possible, by the anthroposophical world centre at Goetheanum in Dornach, Switzerland, and these activities are carried out by individuals around the world in complete freedom. [15]

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Appendix 1.

Selected scientific articles on effects from the biodynamic preparations

E. Jarienė, N. Vaitkevičienė, H. Danilčenko, A. Tajner-Czopek, E. Rytel, A. Kucharska, A. Sokół-Łętowska, M. Gertchen, M. Jeznach (2017): Effect of biodynamic preparations on the phenolic antioxidants in potatoes with coloured-flesh. Biological Agriculture & Horticulture 33(3), p172-182. https:/doi.org/ 10.1080/01448765.2017.1313174.

[When sprayed with the biodynamic preparation 501, the concentrations of total phenolic compounds in the potato tubers of two cultivars were significantly higher; the use of both preparations (500 and 501) had significant effects on anthocyanins accumulation in the tubers of two cultivars; preparation 500 showed a tendency to reduce the concentrations of antioxidant compounds and antioxidant activity in tubers of all cultivars]

E. Juknevičienė, H. Danilčenko, E. Jarienė, J. Fritz (2019): The effect of horn-manure preparation on enzymes activity and nutrient contents in soil as well as great pumpkin yield. Open Agriculture 4, p452-459. https:/doi.org/ 10.1515/ opag-2019-0044.

[For a pumpkin crop, a higher activity of the soil enzymes urease and saccharase was found when applying the horn-manure preparation (500); the average soil CO_2 flux value was significantly higher in the middle of the growing season; and the yield of pumpkin was significantly increased by 18% with horn-manure preparation treatments]

A. Morau, H-P. Piepho, J. Fritz (2020): Growth responses of garden cress (Lepidium sativum L.) to biodynamic cow manure preparation in a bioassay". Biological Agriculture & Horticulture 36(1), p16-34. https:/doi.org/ 10.1080/01448765.2019.1644668.

[At low doses, a significant effect of the horn manure preparation (500) was found on cress root growth at early stages, with a stabilising pattern of action; this effect may induce an increased resilience of the agricultural system]

J.R. Reeve, L. Carpenter-Boggs, J.P. Reganold, A.L. York, W.F. Brinton (2010): Influence of biodynamic preparations on compost development and resultant compost extracts on wheat seedling growth. Bioresource Technology 101, p5658-5666. https:/doi.org/10.1016/j.biortech.2010.01.144.

[Water extracts of finished composts were used to fertigate wheat seedlings, with and without added inorganic fertilizer; mixtures based on compost treated with biodynamic compost preparations had significantly greater dehydrogenase activity than the untreated control, indicating greater microbial activity in the preparation-treated compost]

A. Sradnick, M. Oltmanns, J. Raupp, R.G. Joergensen (2018): Microbial Biomass and Activity down the Soil Profile after Long-Term Addition of Farmyard Manure to a Sandy Soil. Organic Agriculture, 8, p29-38. https:/doi.org/ 10.1007/s13165-016-0170-6.

[Long-term application of farmyard manure, especially in biodynamic cultivation with preparations, resulted in a subsoil microbial community with a more efficient use of soil carbon and glucose]

S. Vaish, N. Garg, I.Z. Ahmad (2021): Bioprospecting of microbial isolates from biodynamic preparations for PGPR and biocontrol properties. Journal of Environmental Biology, 42, p644-651. https:/doi.org/ 10.22438/jeb/42/3/MRN-1529.

[Microorganism isolates from biodynamic preparations showed strong effect on plant growth indicators, as well as biocontrol and enzymatic properties]

Appendix 2.

Selected lectures from R. Steiner on nutrition for the workmen at Goetheanum, Dornach, CH

Sept. 22nd 1923; Collected Works vol. 350 (CW/GA350)

Keywords: The relationship between our foods and the spiritual world. The basic functions of proteins, fats, carbohydrates, and salts. Without the salts in the brain, humans will become weak-minded. Without the carbohydrates the human stature would be deform in various ways. The role of the etheric body in making the fat useful in our body. Protein as what basically forms the human, and without the ability to digest protein, a person would quickly die. Our inability to digest the potato makes it a burden to our 'head digestion'. An excessive potato consumption weakens our ability to think on spiritual matters based on the 'middle brain'. The development of our four bodies relative to potato consumption, as opposed to grain foods. The scientific and theological opposition to the anthroposophical movement.

July 31st 1924; Collected Works vol. 354 (CW/GA354)

Keywords: Our nutrition must contain protein, fats, carbohydrates, and salts. The interdepence of humans, animals, and plants, whereby the breathing of plants and of humans people and animals is a mutual process. The role of the head and salts in forming the human being. How the carrot can support and strengthen our development, as opposed to the potato. The human being is strengthened through the forces used in the conversion of carbohydrates into starch and sugar. The grain as the healthiest food. The potential positive effect of heating and cooking food, as opposed to exclusively raw food consumption. The root nourishes the human head, the leaf the breast, whereas fruits and seeds strengthen the lower body. The difference in plant and animal protein for building strength. Excessive protein consumption is unhealthy, poisoning the body, and leading to arteriosclerosis.

August 2nd 1924; Collected Works vol. 354 (CW/GA354)

Keywords: The lack of memory in the body for forming new proteins. These are formed based on protein 'blueprints' from our foods. Plant protein as the healthiest for the body. The protein quality depends on the cow manure as basis for a fertile soil for the crop. The hardening and 'sclerotisation' of the human development in case of mineral fertilisation. The connection between consumption of potatoes and the brain development.

September 16 1922; Collected Works vol. 347 (CW/GA347)

Keywords for the initial part of the lecture: The role of enzymes in our digestion. Here, ptyalin works in the mouth, pepsin in the stomach, whereas trypsin works in the intestines. Both the etheric body, the astral body, and the 'I-organisation' are active in all three enzymes, whereby the etheric body is most active in ptyalin, the astral body in pepsin, and the I-organisation in trypsin. The latter excretes the 'foreign' etheric and astral forces of the food.

Appendix 3.

Selected educations in biodynamic agriculture

For an overview of biodynamic education centres from around the world which are connected to the Biodynamic Federation Demeter International, see https://www.demeter.net. Here, three comprehensive, European educations in biodynamic farming and gardening are listed, in which the students work and study at the same place. Subsequently, selected courses and educations from around the world are listed, in which farm apprentices and co-workers can participate in courses outside the farm. Shorter courses on all aspects of biodynamic agriculture can be found at the websites of the national organisations.

Comprehensive, European educations in biodynamic agriculture

ENGLAND
Name: Emerson College.
Address: Hartfield Road, Forest Row, East Sussex RH18 5JX, United Kingdom.
Framework: a 1-year full-time residential course, including theoretical and practical introduction to biodynamic farming and gardening. Language: English.
Website: https://www.emerson.org.uk. Email: bookings@emerson.org.uk.

GERMANY
Name: Landbauschule Dottenfelderhof.
Address: Dottenfelder Hof 1, 61118 Bad Vilbel.
Framework: a 1-year, full-time residential course, including theoretical and practical introduction to biodynamic farming and gardening, and state-recognised final diploma. Language: German.
Website: https://en.dottenfelderhof.eu/englisch/agricultural-school.Email: lbs@dottenfelderhof.de.

NETHERLANDS
Name: Warmonderhof.
Address: Wisentweg 10, 8251 PC Dronten.
Framework: a 4-year, full-time residential course, including theoretical and practical introduction to biodynamic farming and gardening. Language: Dutch.
Website: https://www.aereswarmonderhof.nl. Email: warmonderhof@aeres.nl.

Additional courses and educations in biodynamic farming and gardening

AUSTRALIA
Name: Biodynamic Education Centre.
Address: PO Box 1017, Queanbeyan, NSW 2620 Australia.
Framework: a 2-year study program, requiring approx. 5 hours per week, in parallel to practical farm work, based on a distance education certificate program. Language: English.
Website: https://www.biodynamiceducation.com. Email: info@biodynamiceducation.com.

Name: Australian College of Biodynamic Agriculture.
Address: Tarwin, VIC 3956, Australia.
Framework: a 40-week course, based on work on biodynamic farms, including 2 days full time, home-based reading and assignment work. Language: English.
Website: https://www.biodynamiccollege.com. Email: info@biodynamiccollege.com.

EGYPT
Name: SEKEM Vocational Training Centre.
Address: 3 Cairo-Belbes Road P.O. Box 2834, El Horreya, Heliopolis, 11361 Cairo, Egypt.
Framework: a full-time course, with a theoretical and practical introduction to biodynamic farming and gardening, inspired by the Warmonderhof curriculum, and adapted to state regulations.. Language: English.
Website: https://www.sekem.com. Email: cs@sekem.com.

ENGLAND
Name: Biodynamic Agricultural College.
Address: Gloucester Street, Stroud GL5 1QG.
Framework: a 2-year, work-based training, with a theoretical and practical introduction to biodynamic farming and gardening. Language: English.
Website: https://www.bdacollege.org.uk. Email: info@bdacollege.org.uk.

FRANCE
Name: Maisson de l'Agriculture Bio-Dynamique.
Address: 5 Place de la Gare, F-6800 Colmar.
Framework: a 2-year, work-based training, with a theoretical and practical introduction to biodynamic farming and gardening. Language: French.
Website: https://www.bio-dynamie.org/formations/formation-diplomante-bprea/.

GERMANY
Name: Fachunterricht für Lehrlinge auf Demeter-Betrieben.
Framework: a 2-year, work-based training, with a theoretical and practical introduction to biodynamic farming and gardening. Language: German.
Arbeitsgemeinschaft für Biologisch-Dynamische Wirtschaftsweise Nordrhein-Westfalen.
Website: https://www.freie-ausbildung-nrw-hessen.de.
(Similar education can be found for other regions of Germany)

SCANDINAVIA
Name: Bingn - Biodynamic initiative for the next generation - Nordic.
Address: c/o Biologisk-Dynamisk Forening, Engebrets vej 3, NO-0275 Oslo, Norway.
Framework: a 3-year, work-based training for co-workers in Norway, Denmark, Finland, and Sweden, along with week courses. Language: English.
Website: https://www.bingn.org. Email: biodynamisk@biodynamisk.no.

SOUTH AFRICA
Name: BDAASA, Biodynamic Agricultural Association of Southern Africa.
Address: 35 United Rd, Westering, Gqeberha, 6025, South Africa.
Framework: a 2-year, work-based training, and online introductory and workshops sessions. Language: English.
Website: https://www.bdaasa.org.za. Email: info@bdaasa.org.za.

SWITZERLAND
Name: Biodynamische Ausbildung Schweiz.
Address: Ochsengasse 8, 8462 Rheinau.
Framework: a 4-year, work-based training, with a theoretical and practical introduction to biodynamic farming and gardening, including a state accredited final phase. Language: German.
Website: https://www.demeterausbildung.ch. Email: info@demeterausbildung.ch.

Name: Vertiefungswoche Landwirtschaft und Anthroposophie.
Framework: a week-course with introduction to biodynamic agriculture and anthroposophy.
Time of year: January. Language: German. Location: Goetheanum, 4143 Dornach.
https//www.sektion-landwirtschaft.org:

UNITED STATES
Name: BDA Biodynamic Farmer Training.
Address: PO Box 557, East Troy, WI 53120.
Framework: a 2-year work-based training, with a theoretical and practical introduction to biodynamic farming and gardening. Language: English.
Website: https://:www.biodynamics.com. Email: info@biodynamics.com

‘Food quality is about more than the minerals, carbohydrates, fats, proteins, fibres, and vitamins which are listed on the supermarket product labels. We do get relevant information from these labels, but vegetables, fruit, and grains are living organisms, and we must perceive, grow, and examine them accordingly…

The saying ‘A healthy soil gives healthy plants which give healthy animals and humans’ was originally coined by organic agriculture pioneers. It summarises the overall challenge faced by the farmer: to make the farm soils ever more fertile, manage a balanced animal husbandry, take care of biotopes and perennial tree areas, and integrate the farm into the surrounding landscape. The farmer is not a manager of an industrial production; instead, he/she is orchestrating a farm organism, an individual farm entity. The farmer has at his/her disposal the biodynamic field and compost preparations which can stimulate plant growth and the uptake of nutrients and forces from the soil and the atmosphere, with the goal of reaching an optimal fruit formation stage. Based on a spiritual ABC of plant growth, encompassing physical, etheric, astral, and higher forces, the farmer can bring forth crops which are nutritious for the body, soul, and spirit.’

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