Section Five

Nutrition for Plants and Soils

Contents

Maintaining Fertility in a Biodynamic System

Field Advisor Terry Forman reports on a common question that comes up in relation to BD. He claims that the 'first law of agriculture' (i.e. the proposition 'that nutrients going out the farm gate must be replaced by fertilisers brought back in through the gate') is a result of looking at only a limited part of the agro-ecosystem.

Some weeks ago I had the opportunity to spend several hours with the final year Rural Science students at University of New England – Armidale. There was a lecture about the principles of Bio-Dynamic agriculture followed by demonstrations of stirring '500', making compost and using the compost preparations, 502-507.

There was a fair degree of attentiveness shown by students. However there was also, quite naturally, a good measure of scepticism, especially with regard to the main principle underlying BD agriculture. This principle recognises the farm as a self-sufficient organism which can achieve a sustainable level of production without routine mineral inputs (as bought in fertilisers) and with negligible rundown of soil resources. The attempt to realise this principle centres, of course, around the use of small amounts of the BD preparations which activate those forces of nature which drive the biological processes in the soil/plant/animal mix on the farm.

The scepticism came, not so much from the use of the preparations, as unusual as they might seem at first glance, but because such a farm would be acting contrary to what could be called the 'first law of agriculture'. This law broadly states that the amount of minerals (ie N, P, K etc) going off the farm as production and other losses, must be replaced by minerals coming onto the farm as brought-in fertilisers, if soil fertility and hence production is to be maintained.

This question: "how do you replace the nutrients that go out the farm gate?" is in fact probably the most common one asked at any Bio-Dynamic field day or lecture. Unfortunately it cannot be answered with the same ease and simplicity with which it can be asked. And this is because we often accept conclusions, in this case the First Law of Agriculture, drawn from what are in face a limited range of observations.

So all we can do is begin to work towards an answer by extending our range of observations and awakening our imaginations!

There have already been many thousands of experiments done throughout the world in laboratories and in the field which seem to support the 'First Law'. However there are also now an increasing range of observations made on farm situations which are being run on 'ecological' principles. Prominent among these are studies of long term organic and BD operations. There is even a re-enactment of a prehistoric Celtic farm in the UK. All these studies seem to show that after a certain settling down period an equilibrium situation is established, and from one year to the next crop and animal yields remain constant (with minor variations according to seasonal conditions) along with nutrient levels in soils, plants and animals.

This equilibrium situation is referred to as a condition of homeostasis. The process by which this condition is achieved is not really understood.

In order to achieve some understanding I think we really must be prepared to make an attempt to understand the living formative forces which are obviously at work in the farm situation. And to do this I think a very good starting point is the set of Agriculture Lectures of Rudolf Steiner – the basis of the Bio-Dynamic method.

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In these lectures we come to see that a plant does not only exist here on earth: that what we see, feel and smell immediately before us is only a part of the whole plant. There are other parts or aspects of the whole plant which are spread out through the cosmos, but particularly centred in the sun, moon, and other planets; and yet other parts which are centred in different parts of the 'fixed star' realm of the zodiac beyond the solar system. We could make a comparison here between plant growth and weather patterns. A picture of a tornado might be a useful analogy of what I am trying to express.

The intensive area of low pressure which is really the essence of the tornado is only made visible because of the moisture, soil, organic debris which the spirally movements of air have sucked towards the centre. However the tornado cell extends, in the upper atmosphere especially, over hundreds, or even thousands of kilometres, and it in turn relates to all the other high and low pressure systems of spirally air movements which are present at that season on the earth. Remember that a season is just a particular relationship between earth, solar system, and zodiac.

Thus we can begin to imagine plants as tiny living tornado-like creatures which also suck moisture, soil and organic debris to the centres. But in the case of plants they are actually living creatures which have a sectional 'etheric' life centre which is connected directly to the inner living part of the sun as well as the outer part of the sun (light and warmth) which our weather systems are more connected to.

So a picture can begin to form of the nutrients, which are being drawn into the influence of the whole plant, as also having aspects of their nature beyond what we can immediately weigh and measure here on earth. And like the plant which is constantly changing through its forms of seed, root, leaf, flower and fruit; the mineral nutrients are also constantly changing from one part of their cycle to another. Steiner has stressed that these extra-terrestrial parts of their cycles are very significant. They can perhaps be thought of as being more in the form of warmth, or light or even something akin to a sound vibration. That is in a form of energy, and even beyond that as a pre-energy or spirit-form. It then can be seen how a farming method which does not stress the importance of the farm being seen as a biological entity which is responsive to the whole cosmos, might only have a stunted development of some of the nutrient cycles and thus would need to be constantly topped up from outside. It is also interesting in this regard to ponder the fact as presented by Steiner that the mineral substances that we have here on earth are actually 'decayed light', almost like a manure, left behind by the light assimilation processes of the primordial living plant/mineral forms.

In the last pages of Lecture Five of the Agriculture Course we are told also that there are transmutations from one mineral to another under the influence of biological pressures and that the compost preparations are intended to enhance these activities:

"For there is a hidden alchemy in the organic process, which transmutes the potash, for example into nitrogen, provided only that the potash is working properly in the organic process.....And the nitrogen which is formed in this way is of the greatest benefit to plant growth" (See Lecture Five, page 98)

Many people have derived much food for thought on this subject from the book "Biological Transmutations" by C.L. Kevran.

Soil Fertility in a Biodynamic System

A biodynamic practitioner uses his physical, mental and spiritual powers to enliven the soil so that it is receptive to the stream of cosmic forces. He would bring all inputs into a living state before adding to the soil. He would ensure that all nutrients remain in the colloidal state.

Building and maintaining humus levels over three percent is one of the main interests of the biodynamic practitioner. Using the formative energies of the vortex and the chaos, establishing a wide diversity of plants and crop rotations are other practices to sustain the physical, biological and chemical processes in the soil.

Also to be mentioned are establishment and maintenance of good soil structure, drainage, moisture levels, aeration and organic matter levels. As well as green manuring, rotational grazing of animals, fallowing, regular use of all the biodynamic preparations, application of compost, liquid manures and manure concentrate.

A biodynamic practitioner uses biological inputs, perennial pasture species, protection of the soil from the adverse effects of wind, sunlight and water, recycling of all organic matter (plant and animal) and correct cultivation methods to build and sustain healthy soils. He feeds plants naturally and according to their requirements, enhances root development and microlife and maintains the soil pH between 6.0 and 7.5.

Ricardo Hurtig, Biodynamic Education Centre Certificate Program, June 2009

Biological Transmutation

excerpt from C. Louis Kervran via BD Now site

Crabs, shellfish and crayfish have shells made largely of calcium. A crab 17cm by 10cm has a shell weighing around 350 grams. Periodically these animals shed their shell and create a new one. This is called molting. When molting, a crab is very vulnerable and hides away from all other creatures – proving that it does not get calcium by preying on other creatures.

According to French chemist C. Luis Kervran of the Conseil d'Hygiene in Paris, seawater contains far too little calcium to account for the rapid production of a shell (the calcium content of sea water is about 0.042% and a crab can form a new shell in little more than one day). If the entire body of a crab is analysed for calcium, it is found to contain only enough calcium to produce 3% of the shell (even taking into account the calcium carbonate stored in the hepato-pancreas just before molting).

Even in water completely devoid of calcium, shellfish can still create their calcium-bearing shells as shown by an experiment performed at the Maritime Laboratory of Roscoff: "A crayfish was put in a sea water basin from which calcium carbonate had been removed by precipitation; the animal made its shell anyway". (Kervran 1972, p.58)

"Chemical analysis made on animals secreting their shells has revealed that calcium carbonate is formed on the outer side of a membrane although on the opposite side of the membrane, where matter enters, there is no calcium. This fact has left specialists perplexed." (Kervran 1972, p.58)

Seawater contains a sufficient amount of magnesium to form a shell if we accept Kervran's proposition that crabs routinely transmute magnesium into calcium;
Mg + O = > Ca.

It would be interesting to put a crayfish in water devoid of both calcium and magnesium and see if it can still create its shell.

Normal egg shells produced by hens contain calcium. Kervran (1972, p.41) reported an experiment in which hens were confined in an area in which there was no source of calcium and no calcium was present in their diet. The calcium deficiency became clearly manifested after a few days when the hens began to lay eggs with soft shells. Then purified mica (which contains potassium) was given to the hens.

Kervran (1972, p.41) described what then transpired: "The hens jumped on the mica and began scratching around it very rapidly, panting over it; then they rested, rolling their heads on it, threw it into the air, and began scratching it again. The next day eggs with normal shells (weight 7 grams) were laid.

"Thus, in the 20 hours that intervened, the hens transformed a supply of potassium into calcium…An experiment of this kind, using the same mica, was undertaken with guinea-fowls over a period of forty days. The administering of the mica was suspended three times and each time a soft-shelled egg was laid…"

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One might suggest that the calcium in the egg shells was borrowed from the bones of the hens. But if this is true, why were soft eggs laid when the mica was withheld and normal eggs laid when mica was given to the hens?

In order to avoid the conclusion that the hens transmuted potassium into calcium, one would have to show that mica somehow stimulates a metabolic pathway in which calcium is removed from the hen's bones and used in the production of the egg shells.

This could be completely refuted by feeding the hens mica (and of course absolutely no calcium) for such a long period of time that all the calcium in their bones would have been completely exhausted. If after that time the hens still produce calcium-bearing egg shells, we must conclude that the calcium in the egg shells is not being taken from the bones. At that point, we seem to have no choice but to acknowledge the transmutation of potassium into calcium within the hens.

Transmutation, Destruction and Creation of Matter

When the biological life of the soil is maintained and the biodynamic preparations are used to enhance the etheric streams in Nature, biological transmutations, from one element to another are possible. The biodynamic compost preparations are intended to enhance these organic processes.

Biological transmutations are occurring all the time. The greater the biological life of the soil the greater its capacity for transmutation of the elements.

"The biodynamic preparations enhance the etheric streams passing through the soil, setting up conditions for greatly improved biological transmutations.

"For there is hidden alchemy in the organic process, which transmutes the potash for example into nitrogen, provided only that the potash is working properly in the organic process....and the nitrogen which is formed in this way is of the greatest benefit to plant growth." R. Steiner

This concept of the possibility of biological transmutations defy the laws of conventional chemistry and biology, laws which were developed in closed laboratory conditions where soil and plant life are isolated from their biological, living aspects.

For extra reading on this subject refer *Culture and Horticulture* Wolf Storl, Chapter 5, Transmutation, Destruction and Creation of Matter.

Elemental Transmutations

By Hugh Lovel

"Because of their limiting assumptions, many soil chemists pooh-pooh the idea of biological transmutation. Yet there is biological transmutation.

"In boggy, compacted fields, especially in winter, oxygen-starved bacteria transmute such isotopes as potassium 39 and calcium 40 into sodium 23 and magnesium 24, yielding oxygen 16. When cultivated in spring, these same soils absorb oxygen 16, transmuting sodium 23 and magnesium 24 back into potassium 39 and calcium 40. In other examples, iron 26 plus oxygen 16 forms molybdenum 42, essential for effective nodulation in legumes. With chickens eating a diet rich in potassium 39, hydrogen 1 reacts to form calcium 40.

"Aware of transmutations in the twenties, Rudolf Steiner stated in his agriculture lectures that under the influence of hydrogen, potash and even lime transmute first into something resembling nitrogen and then into nitrogen.

"Rudolf Hauschka's and Louis Kervran's experiments of sprouting seeds in closed systems not only showed that a wide variety of biological transmutations occur, but Hauschka (The Nature of Substance) showed that mass in such systems is lost or gained according to the rhythms and cycles of the sun, moon and other celestial bodies.

"All that is lacking here is a good enough mapping of the pathways of transmutation for the world scientific community to embrace the idea".

Hugh Lovell, *A Biodynamic Farm,* 1994, Acres USA

Further information relating to the transmutation of elements refer to:

- Elemental Transmutation in Biological Systems: Evidence that atoms behave differently in biological system than outside of them.
- Madhavendra Puri, The Bhaktivedanta Institute
- http:/ / www.keelynet.com/biology/bioxmute.htm

Justus Von Liebig's N-P-K Theory

Justus von Liebig (b 1803, d 1873) was a German chemist who made major contributions to agricultural and biological chemistry, and worked on the organization of organic chemistry. As a professor, he devised the modern laboratory-oriented teaching method, and for such innovations, he is regarded as one of the greatest chemistry teachers of all time. He is known as the "father of the fertilizer industry" for his discovery of nitrogen as an essential plant nutrient, and his formulation of the Law of the Minimum which described the effect of individual nutrients on crops.

Conventional, chemically-based agricultural and horticultural practices were first introduced by Justus von Liebig. He deduced from analysing the ashes of plants that he had burnt that plants were composed of ordinary chemicals. This led to the development of synthetic chemicals to meet the nutritional requirements of plants. This way of viewing the living world as being merely composed of ordinary chemicals does not take into account that plants and animals are composed of more than just chemicals; they are living organisms.

N-P-K Theory
-von Liebig's quotation sited by Charles Walters in *Fletcher Sims' Compost*

The simplistic nitrogen-phosphorus-potassium idea harks back to von Liebig's lectures before the British Association for the Advancement of Science, at which time he made the point that "the primary source whence man and animals derive the means of their growth and support is the vegetable kingdom. Plants, on the other hand, find new nutritive materials only in inorganic substances." Von Liebig translated this to mean that one had to analyse by an ash test the produce of an acre and "return the nutrients" used to maintain fertility. The end of this line of thinking came in 1843, when von Liebig issued his mea culpa"

Von Liebig's Mea Culpa
I had sinned against the wisdom of our creator, and received just punishment for it. I wanted to improve his handiwork, and in my blindness, I believed that in this wonderful chain of laws, which ties life to the surface of the earth and always keeps it rejuvenated, there might be a missing link that had to be replaced by me – this weak powerless nothing…

What might justify my actions is the circumstance, that a man is the product of his time, and he is only able to escape the commonly accepted views if a violent pressure urges him to muster all of his strength to struggle free of these chains of error. The opinion, that plants draw their food from a solution that is formed in the soil through rainwater, was everyone's belief. It was engraved into my mind. This opinion was wrong and the source of my foolish behaviour.

When a chemist makes mistakes in rating agricultural fertilizers, don't be too critical of his errors, because he has had to base his conclusions upon facts which he can't know from his own experience, but rather, has to take from agricultural texts as true and reliable. After I learned the reason why my fertilisers weren't effective in the proper way, I was like a person that received a new life. For along with that, all processes of tillage were not explained as to their natural laws. Now that this principle is known and clear to all eyes, the only thing that remains is the astonishment of why it hadn't been discovered a long time ago. The human spirit, however, is a strange thing: "whatever doesn't fit into the given circle of thinking, doesn't exist."

Harvey Lisle, *The Enlivened Rock Powers*, pgs 118, 119

Stirring Methods Used for the Biodynamic Preparations

When I first became involved in Biodynamic practice twenty years ago, the methods used for stirring the biodynamic preparations were either by hand stirring or for larger acreages, through the use of stirring machines. These two methods duplicated the vortex/chaos method for stirring the biodynamic preparations as first developed by Rudolf Steiner and later refined by the experimental circle.

The role of the experimental circle was to develop the biodynamic method of agriculture in accordance with the guidelines given by Rudolf Steiner. The experimental circle consisted of many remarkable people, deeply knowledgeable of Anthroposophy – this gave the members the framework for understanding Rudolf Steiner's approach to agriculture. Over the next twenty five years the biodynamic method, as we know it today, was developed. The biodynamic method has had remarkable success and has remained relatively unchanged until recent times.

In the last decade many changes have been made to the biodynamic method. This can especially be seen in the whole approach to the stirring process: the water is not always warmed; sometimes the preparations are applied, as per a prearranged schedule; and, in the case of contract stirrers, the soil is not always moist or in the best condition to receive the life forces contained in the preparations.

Change is inevitable; everything on this planet is in continual motion, nothing remains the same. Change in itself can be beneficial or negative according to the way it is brought about. To make changes in the practice of biodynamics, it is necessary to first consider the importance of entering into a period of experimentation. This requires a stage of close observation and precise record keeping. It takes many years of close observation before any significant changes can be seen. Rudolf Steiner mentions in the agriculture lectures that everything in Nature is in a cycle of four years (or four generations). This should therefore be considered the shortest timeframe for any experimentation.

One would hope that anyone promoting a change in biodynamic practice would have undertaken at least this period of experimentation. Unfortunately this is not what is occurring; what is more likely to occur is that someone is likely to identify a result/benefit from their action and readily promote this as a new or improved approach to biodynamic practice. New practitioners to the biodynamic method readily adopt the new approach, as they have neither the background nor experience in biodynamics from which to discern the benefits or challenges brought about by these new practices. Very soon the new approach becomes increasingly popular and then readily gets adopted as 'standard biodynamic practice.'

This seems to be what has occurred in the case of flowforms which have become increasingly popular with many new biodynamic practitioners adopting these for the stirring of the biodynamic preparations. If we trace the history of the use of flowforms to stir the biodynamic preparations we find that their popularity first came about in New Zealand. Flowforms were initially used to enliven fish emulsion – for which they are ideal, but later were used for stirring the other biodynamic preparations as well. The action of water meandering through a flowform is very beautiful so one can see how they attract our attention, whereas stirring machines do not have the same aesthetic appeal as the flowform.

Research was conducted at Emerson College between 1990 and 1993 to compare the effectiveness of hand stirring, flowform stirring, and machine stirring of the biodynamic preparations. The results of this research are often promoted as conclusive evidence that flowform stirring is more effective than machine stirring. However, if one reads the research papers from this experiment one finds many flaws in the way in which this research was conducted. Firstly, to replicate the action of the stirring machine an electrical kitchen mixer was used. This apparatus could only be operated at a high speed – the researchers noting that it seemed to be cutting the water. This is definitely not an action which occurs when using a stirring machine. It becomes immediately clear that one could never get a positive outcome from the use of a kitchen whisk to replicate hand stirring or a modified kitchen mixer which cuts the water to replicate a well tuned stirring machine. [1] Later in the experiment, the water used for stirring the preparations was not warmed for some applications of the preparations but was warmed for others. Therefore this outcome could not be strictly compared to the other treatments when the water was warmed prior to stirring.

Apart from the lack of evidence that flowform stirring brings a better result than when using a stirring machine to stir the biodynamic preparations, one can use one's own understanding to compare these two approaches to the stirring process. To do this one first needs to identify the biological, chemical and life processes which occur when the preparations are stirred.

The vortex is a figure complete in itself with its own forms, rhythms and movements. On closer examination we find that it has different speeds of movement, slow on the outside and fast through the inside.[2] All living vortices have these inward and outward streams flowing faster down the centre of the vortex and then slower coming up.

We create these slow and fast moving streams of water when we use the vortex movement in the stirring of the biodynamic preparations. When the direction of stirring reverses thousands of vortices are created.

Chaos

When stirring the biodynamic preparations, as soon as we create the vortex it is destroyed to create chaos in the water, thus mirroring one of the basic tenets of life, that of order arising out of chaos. Rudolf Steiner mentions in the agriculture lectures that if you want to make earthly matter open to spiritual forces you must drive earthly matter as far as possible into chaos. When stirring the preparations water is the medium through which the forces of the cosmos are captured; therefore it is essential that a proper chaos action is part of the stirring process.

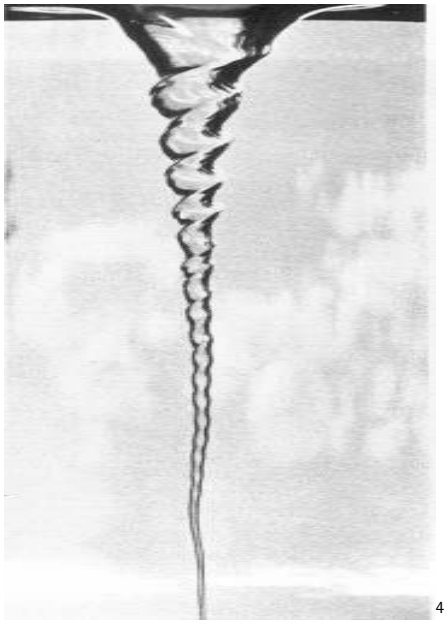
The Chelation Principle

It is possible that when the water is stirred into a vortex, the forces exerted on the weak bonds between the water molecules charges them. The weak bonds are stretched or rearranged so that the water as a whole takes on some of the chacteristics of the preparation that is being stirred.

[1] Reference Newsleaf, Number 29, Oct 1996

[2] Schwenk, T., *Sensitive Chaos*, Rudolf Steiner Press, p44, 1965.

"To find out just how much charge is generated by a vortex four inches in diameter, Patrick Flanagan lowered a thin specially shielded wire electrode into the centre of its vortical throat, being careful not to allow the wire to touch the water. By means of another electrode touching the water he was able, while the vortex was moving at approximately one thousand revolutions per minute, to record a charge of more than ten thousand volts emitted from its swirling water; quite a boost from the cosmos."[3]



Vortex photographed underwater reveals the spiralling between the water and the air which is being sucked in.[4]

The fast spinning movement of the vortex causes water to release an electrical charge. This negatively charged water attracts cations and minerals, both positively charged elements, from within the water and the surrounding atmosphere. These minerals are however not in the form which plants can utilise. For plants to utilise minerals they must first be chelated. This means they must lose their positive charge and become neutral or slightly negative in charge (ionic form). Minerals can then be easily absorbed by the fine white root hairs of plants.

There are only two chelating agents in nature which can perform this function, humus and aerobic bacteria. Water which has been warmed prior to stirring provides the perfect environment for the proliferation of aerobic bacteria whose populations greatly increase during stirring. Aerobic bacteria present in the water chelate minerals attracted to the negatively charged water. Once chelated, these minerals are in the perfect form for the plant to use.

[3] Tompkins, P. and Bird, C., *Secrets of the Soil*, Harper and Row, New York, p109, 1989.
[4] Schwenk, T., *Sensitive Chaos*, Rudolf Steiner Press, p16, 1965.

One of the great pioneers and researchers for biodynamic agriculture, Ehrenfried Pfeiffer, analysed water before and after stirring biodynamic preparation BD501.

"Pfeiffer's analysis showed the bacteria count in quartz powder; nil to begin with, ends up, after stirring, with some forty million aerobic bacteria. His spectrographic analysis likewise showed several changes in the plain quartz dust. Ninety percent silicon dioxide to begin with, it miraculously developed small amounts of nitrate, nitrogen, magnesium, potassium, phosphates, copper, silver, alum, boron, barium, calcium, chromium and zirconium. Iron increased five times, to 1 percent, while magnesium increased one hundred times. Does this amount to creation out of the blue? If so it is a pretty amazing form of agricultural endeavour."[5]

Energised Living Colloids

Fast flowing water subjected to vortical flow is stretched like a rubber band. This stretching of the water changes the electrical charge on the particles of matter suspended in the water thus rendering them 'colloidal'. This colloidal bonding of the organic molecules is extremely important; nutrients should never pass out of this colloidal state. In biodynamic practice all plant nutrients should always be held in the state of the colloid.

Summary

The vortex/chaos movement used when stirring the biodynamic preparations meets the creative impulses of movement behind all living things. By creating these movements in the water we open the body of water to planetary influences.

Energetic vortex stirring of water greatly increases its oxygen content. The enlivened oxygen becomes a carrier of the etheric forces which are then captured and held by the water, which in turn becomes living and energised.

The subjecting of water to vortical action causes the water to release a negative charge attracting minerals and nutrients present in the water and the atmosphere. Vortical stirring using warmed water creates the condition for the proliferation of numerous beneficial microorganisms and bacteria which chelate these minerals into a form readily used by plants. Vortical action also creates highly charged colloids, the perfect form of nutrition for all living organisms.

The wonderful benefits that can be obtained through the action of vortex/chaos stirring can only be fully achieved if the whole body of water is subjected to the vortex/chaos rhythm for the complete hour of stirring. As you stand next to a flowform or a stirring machine, observe these processes within the stirring action. In the flowform you can see the vortex/chaos rhythm for just a moment since a totally different kind of movement is involved, but when hand stirring or using a stirring machine, these movements are embodied in the whole as a single organism. Whilst the decision on stirring equipment is left to the individual, this decision should be based on knowledge gained from a study of the principles we are engaging in the stirring process.

Lynette West, July 2009

[5] Tompkins, P. and Bird, C., *Secrets of the Soil*, Harper and Row, New York, 1989

Stirring the Biodynamic Preparations

By Terry Forman

At a recent meeting of the Circle of Representatives of the Biodynamic movement which took place in Sweden, there was discussion concerning the stirring of the preparations. Dr. Manfred Klett who heads the Biodynamic department at the Goetheanum in Switzerland and leads the Circle stated that "...great uncertainty has arisen with regard to carrying out this step with the preparations around the world. Farmers have come to do this stirring not only by hand, but also by machine and also with the Virbela Flowform cascades. The basis for this lies chiefly in the lack of available workers and also in the size of the area to be treated. Individual ways are also being followed with regard to the length of time of stirring, and also the use of potencies etc."

In pursuing these discussions the aim is not to develop decrees or rules or even recommendations, but rather to assist in furthering our understanding of the processes involved so that individuals and groups can form their own guidelines. This refers to practical work on the farm and to research projects which are being undertaken.

The starting point or discussion, Klett suggests, are the comments made by Steiner at the Agriculture Course. In Lecture 4 Steiner says "You must make sure, however, that the entire contents of the horn have been thoroughly exposed to the water. To do this, you have to start stirring it quickly around the edge of the bucket, on the periphery, until a crater forms that reaches nearly to the bottom, so that everything is rotating rapidly. Then you reverse the direction quickly, so that everything seethes and starts to swirl in the opposite direction. If you continue doing this for an hour, you will get it thoroughly mixed."

And then, as if he was well prepared for how his suggestion of stirring the contents of the horn for an hour, would be received by the farmers present, Steiner takes the initiative, and straight away says "...Just imagine how little work this takes! The burden of labour for these things will not be very great. Besides, I could imagine that otherwise unoccupied members of a farming household might really enjoy stirring the manure, at least for awhile."

In the discussion which follows Lecture 4, Steiner was asked "Is it all right to use a machine to stir the mixture for larger areas, or is that not permissible?" He does not answer yes or no. He says however that "stirring by hand has quite a different significance than mechanical stirring" and that "you can be either quite strict about things like that, or you can decide to gradually slide towards surrogates" He further explains how a persons attitude or enthusiasm can be made effective in subtle ways through work done by hand. Then perhaps, somewhat hopefully he says, "but it could also turn out that doing this stirring is such fun that you wouldn't even consider using a machine, even when a lot of cow horns were needed. It could be something you do on Sundays after lunch. Then if you invite a lot of guests and provide some entertainment, you could get it done just beautifully without machines!"

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There are many people with whom these ideas would strike a chord and whose practices have been influenced by them. There have certainly been many wonderful hands on days, at the local level where groups of people have gathered together to make the preparations. There are however many farmers, especially in countries like Australia, who would find these ideas and sentiments impractical for their own situations. In Australia, as farmers, we are often working alone or with minimal help, and the mechanisation of many farm tasks has become common, especially during the last twenty years. There is also a high rate of invention and innovation of new mechanical methods by individual farmers. It is hard to imagine the enthusiasm for applying Biodynamic preparations over such large areas, being maintained without the use of mechanical aids for both stirring and spraying.

By way of contrast, Klett has described his own experiences of stirring preparations, during his agricultural career in Europe, as taking place in three phases. In his early years, as an apprentice, being given the job of stirring the preparations for an hour, with another apprentice, was like being given "time out" from other farm work. It was able to serve as a time of inspiration and insight into what was happening on the farm.

Later, when he was involved in various biodynamic research projects, many stirrings had to be done alone, and the work became more repetitious and onerous, rather than inspirational. He determined at that time, that when he returned to farming, he would try always to do the stirring with other people, so as to lessen the labour and help maintain the enthusiasm.

In the following years, Klett, together with four other farmers, founded and began work at the Dottenfelderhof farm. Community principles were at the forefront of this project, and from the outset it was decided to always stir the preparations by hand, and with at least three people. Some 40 years later, Dottenfelderhof, now a highly productive farm with nine farm families plus apprentices and co-workers, still stirs the preparations by hand, even though much of the other farm work is highly mechanised.

I think we can be justified in making the observation "Well, it's horses for courses". The fact is, that in Australia and New Zealand, with the use of stirring machines and flowforms, farmers have been able to achieve significant and continuing effectiveness of the biodynamic methods, with the use of mechanical stirring aids, and not without adding a certain "personality" to the way the machines are utilised and manufactured.

Given the nature of the whole farming situations here, it would have been surprising if farmers hadn't invented stirring machines or applied flowforms to stirring the preparations. In fact, you often see at field days here, either an operating stirring machine or flowform set up to attract passers by.

Uli Konig, who is a researcher in Germany, was at the meeting in Sweden and he put forward the following ideas in an attempt to chacterise the different nature of machine and flowform/pump methods of stirring the preparations, and how they stand in relation to hand stirring. "In what follows, a few observations will be reported on, gained in the framework of the "Preparation Stirring Project" being carried out at the Institute for B-D Research, Darmstadt, and the Institute for Flow Dynamics, Herrischried. In this project, various stirring methods (by hand, machine and flowforms) were compared. In this, the hand stirring was set up as the ideal, by which others were measured. The observation of stirring can be done on various levels. The first basic level is the flow phenomenon, that is, the transformation of the vortex.

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Rudolf Steiner described how the ideal vortex should look exactly in the Agriculture Course: in a half filled vessel (pail) the stirring will be done vigorously around the edge until a "crater" forms, reaching almost to the bottom, the entire mass of water being in rotation (as in the first drawing). We are not talking here of a "funnel", which arises as a rule when the vessel is practically full and the stirring is done not at the edge, but more towards the middle (as in the second drawing).

The transformation of the stirred vortex proceeds by the following stages:

1. When one begins to stir the standing fluid, there arises in it a number of static eddies, those below drawing the water from the periphery along the vessels bottom toward the centre, where it then rises and is pushed outwards. Hereby all of the not yet dissolved matter (e.g. part of the silica preparation) is deposited on a little pile in the middle. These ring eddies are interspersed by rhythmic waves as well (one can see this happen with fine quartz sand in a glass vessel).
2. When the speed of stirring is intensified, the water rises gradually at the edge of the vessel, and the crater forms. Along the rim one now has a strong turbulent, shearing flow, in the middle forms the pole of rest, while in between lies the zone of rhythmically formed swirling turbulence.
3. When the water has risen at the rim of the vessel through further stirring and the crater has fully established itself, the whole fluid is in turbulently rotating movement up to the smallish area at the vessels centre, where it is practically quiet.

If the water is now arrested and stirred in reverse, the rotation is halted, while the water tumbles in turbulent disorder. Through this, the little heap of sediment in the centre of the vessel is whirled up and dispersed through the whole. Then the stages of ordering that we have described begin afresh, the vortex is re-established.

Rudolf Steiner laid emphasis on the stirring being done by hand. He gave two reasons for this. First, all the finer movements that modify the stirring process through the human hand are of particular importance. Second, he speaks of the necessary enthusiasm that must be created if the effects of the preparation are not to dissipate. Mechanical stirring, even stirring with matter-of-course efficiency, would with time allow the effects of the preparations to fade away.

Here two questions arise. First, today there are less and less BD farms where the preparations are used with enthusiasm – whether from overwork or lack of understanding. Then what effect do they have? And second, in practice one uses larger and larger vessels of stirring, where the intensive mixing demanded by Rudolf Steiner cannot efficiently be achieved. Is this not a "matter-of-course efficient" way of handling the preparations?.

With these two questions, the problems are touched on which lead to the introduction of stirring machines. In recent years, a relatively large market for these has opened up. Almost everything that finds its application in the mixing of fluids is being recommended for the preparations. A categorical rejection of these methods helps the situation little as their fanatical employment. Far more important is a judgement that has been raised to full consciousness, to be able to decide matters from facts. In what follows, we shall take a closer look at two of these "stirring techniques".

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"Machine Stirring" by means of mechanisms that imitate hand stirrings. At least in Europe, this is the most widespread form of mechanised stirring. There is consequently a great variety of models at present, which are more or less suited for mixing the preparations with water. The observations described here were made on the basis of a stirring machine that imitates well the stirring process described above (the systems of Maria Thun and A. Podolinsky). The machine is controlled electrically so that the stirring speed accelerates, ie So that the direction of the rotation is not changed abruptly.

If we compare this stirring process with hand stirring, it is apparent that with the best possible adaptation to the movements of hand stirring, the resulting movement ends in uniformity. Not much is altered when the direction of the rotation is changed by means of a water level control switch. The stirring process is subject to beat, imposed on it by machine technology. Human care has congealed into the abstract of human intellect and there follows its course, apart from man.

A completely different quality of "Stirring method" is involved when stirring is done with flowforms. Flowforms were developed originally for the rhythmic treatment of water (reconditioning of drinking water, sewage purification etc.). It allows water to flow through extremely manifold form-mutations, spreading out broadly in lemniscates; then shooting on with speed, then mingling intensely with other streams. Here a living, pulsing rhythm arises in the main stream. The optimum mixing of preparation and water by means of flowforms must be derived from the highly differentiated speed of flow: a part of the water shoots through a flowform cascade in a few seconds, while another part can linger up to ten minutes. This treatment by comparison with hand stirring is much more difficult, since a totally different kind of water movement is involved. Although the water flows again and again through the flowform, without an outwardly imposed rhythm (eg. by reversal or revolution) there is no monotony of movement. In each movement a different kind of flow rhythm is apparent. The water seems to be flowing without beginning or end, according to its nature as water (if one ignores the necessity of pumping the water up again). To be sure, man has shaped a bed for this flowform true to nature by an artistic act of creation, yet when the preparation is being stirred one can have the impression that here man should interfere as little as possible in this natural process.

These two described methods of stirring provide us with two extremes. With a stirring machine, man surrenders his activity to a mechanism by isolating this out of nature: with the flowforms he entrusts what is to happen to a natural process which he has constrained artistically in the flowform cascade. In this sense one can say, that hand stirring lies between these two extremes: man is the agent who continually draws the natural process into the stirring, giving a living form to the flowing water, establishing the rhythms an expression of his will in the movements of stirring.

This description is not to be considered as a recommendation that is binding in how one goes about the stirring of the preparations. The individual must decide for himself which way he will go. Still, it is certainly of importance in the sense in which it is discussed in the "Agriculture Course", for what I am "enthusing" myself – for the activity of hand stirring, for a technical-material process or for an artistically directed natural process".

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From all this, I think we can take at least three major points which can serve as guidelines for our own work here.

1. Hand stirring needs to be respected and accepted for what it can offer.
2. Mechanical stirring, by machine or flowform/pump has become an integral part of the current application of BD preparations.
3. Both of these mechanical innovations in stirring are still in their infancy and we ourselves must make decisions concerning their future developments.

It is quite possible to imagine, that through furthering our understanding of what is involved in the stirring process and the applying of our ingenuity, these techniques can be radically improved in the years ahead so that something of the individual human beings involved can ether into the process.

In a series of lectures given the title "the Karma of Vocation", Steiner describes the types of machines we will invent in the future, when we have learnt to utilise the spiritual forces and energies of nature (such as the etheric and astral forces he continually alludes to in the Agriculture Course), like we are now able to utilise the physical energies of nature (such as heat, electricity and nuclear forces). An unusual aspect of such machines will be that they will only be able to be operated by certain individuals. And it will be those individuals who have sufficient ethical merit. Today's machines require only that we have sufficient intellectual and technical merit and are completely oblivious as to what our intents and purposes are. The well known notion of the gardeners "green thumb" might give us some idea of what Steiner is indicating here.

From this we can sense the significance which our attitudes, understanding and enthusiasm have in all we do. How they may be passed, through our hand stirring into the applied preparations, and how they may also serve to bring machines into productive and ethical service.

Newsleaf, Journal of BDAA Australia, No 37, pp 6, 10.

Calcium, Silica and Clay

Calcium
Limestone, which is associated with the terrestrial forces, provides calcium to the soil. Calcium is involved in the forms of plants, the shape of leaves and fruit (and therefore seeds and reproduction). Earthworm activity, soil bacteria and nodulation on legume roots increase when limestone is present in the soil.

Silica
Silica, which is associated with the cosmic forces, is connected to building up the substance of the plant and the formation of starches, sugars and proteins. Silica occurs in nature in hard rocks and in its purest form as silicon oxide in clear quartz crystals.

Clay
Clay, which is the decomposed form of various rocks including granite and basalt, contains materials such as feldspar, bentonite or basalt. At some point in most biodynamic agriculture clay will be used because of its properties. In particular, it is used to balance sandy soils and is applied as a slurry to improve the structure of the soil.

Whereas limestone (calcium) is associated with terrestrial and silica with cosmic influences, clay mediates between the terrestrial and the cosmic.

Calcium and Silica
Written by Roger Leitch

To bring about the balance between the forces of calcium and the forces of silica is the aim of the biodynamic farmer or gardener. When this balance is achieved in the soil, the earthly forces of growth and reproduction come into harmony with the cosmic influences, which bring form, structure and nutritional substance. This balance in the soil brings health to the plants and animals on the land as well as giving strength and vitality of body and soul to those who eat the foods produced this way.

Most of us are familiar with the way in which calcium or limestone is used in agriculture. It is often added to the compost heap and to the farmland or the garden to counteract acidity. We know that silica, in the form of sand, is useful to aid drainage, but it will be new to many people that it plays a much more major role than this.

The Role of Silica
It may be rather surprising for some to learn that silica is present (mainly as silicates) in 90 per cent of the Earth's crust, compared with only 7.6 per cent calcium. It is present in the great granite mountains of New Zealand's Southern Alps, the Austrian and Swiss mountains and the Himalayas. In the form of granite it is present as fine quartz crystals together with feldspar and mica. These other minerals also contain silica, together with a wide range of metals as silicates. (Feldspar, for example, contains 50 per cent silica together with aluminium, calcium, potassium and sodium.) In these high mountains it can also appear as large outcrops of crystals.

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As well as appearing in this crystalline form, silica can combine with water to form a half-fluid-like colloid which can change from a semi-solid gel to a more watery form, e.g., waterglass. In the opals this colloidal state of silica has become solidified. In New Zealand we are familiar with silica in the South Island granite, also in the North Island volcanic basalt (0-20 per cent silica) and as volcanic glass or obsidian. The purest form of silica is rock crystal which as silicon dioxide appears as large hexagonal crystals. This is transparent and is highly valued for optical lens manufacture.

Silica is also present in physical form in the animal skeletons of certain sponges and diatoms, e.g., in diatomaceous earth. In the plant world it appears in spiny outgrowths such as in the stinging nettle. It is also found in the soil as sand and in finely diluted form in the natural world as well as in the air and water.

In the ability to give structure and form, as in the rock crystals and also in crystalline sea-urchin spines and plant hairs, we can see the physical nature of silica revealed. However, in its more finely diluted nature it unfolds a more dynamic effect, endowing substance along with quality. This effect can provide plants with nutritive value as well as an enhanced taste and smell. The dynamic force that is locked up within matter is utilised in homeopathic and anthroposophical medicine. It is released from different plants and minerals by rhythmically diluting them in a homeopathic fashion.

Rudolf Steiner differentiated between physical material substance and the process of its formation, which is a dynamically potent force of becoming. Thus the silica process can be described as a force leading to the crystallisation and the forming of substance, e.g., production of plant spines. This process is not necessarily bound to the substance silica. Only where it has become extremely active does material silica appear as its end-point.

To understand something of this process of silica formation, we must go back to the earliest stages of the Earth's development. At that time the Earth was softer than it is today. Many modern scientists think that the Earth was then covered by a thick fog-like atmosphere containing, among others, the elements carbon, hydrogen, oxygen and nitrogen. Through the effects of heat and light, these elements formed themselves into the first living forms. Rudolf Steiner speaks also of the first beginning of life originating in a thick proteinaceous atmosphere. He points out, however, that silica played a most important role in this process. Finely distributed silica was influenced by the sun's rays to form itself into crystalline plates of a soft, wax-like nature. This influenced the developing plants to take on physical form and, in doing so; they absorbed silica into their inner structure in its more fluid colloidal form. As these plants did, they were deposited on to the Earth and, just as coal was later formed in a similar way from ancient ferns, the residue of these early plants was deposited as silica. Over the eons of time, these deposits became solidified into hard rock.

In the plant world we can see the silica process working in these different ways. Some plants, in spite of growing on silica-poor soil, are able to concentrate silica into a more crystalline physical form. Examples of this are 'cutty grass' or toetoe, with its razor-like spines, and in the horsetail or equisetum plant with its geometrical structure (containing 90 per cent silica). Other plants are able to concentrate silica but hold it from becoming mineralised in a more colloidal, slimy state. Examples of this are borage and comfrey plants. Some other plants, in spite of living on silica-rich soil, have minimal silica content. Here the silica works more in its dynamic form, as the silica process, with its relation to warmth and light, brings radiating colours, fine aroma and taste. We can see this extreme in the dandelion and arnica plants.

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Silica in humankind is found in the skin and in the enclosing connective tissue membranes such as the lining of the lung and bowel cavity. It has a relation to the periphery and the awareness of sense impressions. It is the extreme sensitivity of the peritoneum or bowel lining that gives rise to the extreme pain of appendicitis. The silica process helps to build the sense organs and gives us the capacity to see, smell and taste.

The Calcium Process

Calcium is most familiar to us as limestone or calcium carbonate. It is found in many parts of New Zealand, for example, in the Takaka Hills in Nelson and in the well known Waitomo area where it has been hollowed out by underground rivers to form large caves. The landscape of these limestone hills is gentle and undulating in comparison with the sharp, craggy forms of the Southern Alps with their silica-containing granite, gneiss and schists. Calcium comprises only 7.6 per cent of the Earth's crust, mainly as calcium carbonate (limestone or calcite). This appears in the more superficial layers of the Earth's crust and is thus more visible than silica which is found more in the deeper layers.

While silica combines itself with oxygen to form silicic acid, then metal salts, calcium is more alkaline and can react with acids to form carbonates and phosphates. It can also combine with different metals such as magnesium, iron, zinc and barium. Calcium carbonate can appear as pure limestone or chalk, a powdery dry white mineral, or in crystal from as calcite or aragonite. As well as appearing in the soil in these forms, it can be present in more finely diluted form in the air and water.

In the natural world calcium is present in the shells of molluscs and in the inner skeletons of fish and higher animals as well as in humans. Where silica finds itself on the periphery in the sense sphere, calcium is found at the centre, forming the supporting framework.
The dynamic force of calcium, the calcium process, is revealed in the chemical properties of limestone. Natural lime has an ability to absorb liquids, gases and odours. This is accentuated when it is burnt to quick-lime. This substance can suck up tremendous amounts of water, giving off heat with great vigour and becoming slaked lime. This tendency to greediness, of taking matter into itself is demonstrated even further by slaked lime which sucks up carbon dioxide from the air to become hardened stone again. This process can be experienced by us every time we mix concrete, which is a mixture of sand, gravel, slaked lime and water.

$CaCO_3$ Limestone	⟶	CaO Quicklime	+	CO_2 Carbon dioxide
CaO + Water	⟶	$Ca(OH)_2$		Slaked lime
$Ca(OH)_2 + CO_2$ gas	⟶	$CaCO_3$		Calcium carbonate

The other side of the calcium process can be understood through the origins of limestone. In the early stages of the Earth, much later than the era in which silica originated, there were large areas of sea teeming with primitive animals of the mollusc family. These shellfish excreted the calcium within their bodies on the outside to form shells. Through thousands of years these calcium shells, which were once animal substance, deposited themselves onto the ocean floor and became hardened into the rock we know as limestone.

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Now that we can understand the nature of silica and calcium and their more dynamic processes, we should look more closely at the role they play in agriculture. It is through the spiritual scientific research of Rudolf Steiner that we can gain many useful insights when we understand in greater depth the interrelationships of humankind, the world of nature and the cosmos.

Rudolf Steiner describes how the Earth can be compared with the human body in its threefold nature. In our head we have the main activities of the brain and sense organs, the organs of perception and thought, while in the lower part we have the metabolic processes below the diaphragm with their relationship to the organs of will, the muscles and limbs. In the centre we have the heart and lungs which undergo rhythmical contraction and relaxation and are the expression of our feeling life.

In our metabolic system is the greatest capacity for growth and regeneration. In this lower region, the activities of food transformation and reproduction are present. When we look at the region where these processes are active in the plant world we must consider those parts above the earth in the leaf and stem where photosynthesis occurs and in the flower, the organ of reproduction. In this realm of nature above the Earth's surface, the most material, earthly aspects of the plants are revealed and it is in this sphere that calcium unfolds its influence. Inherent in the nature of animals are the instincts and uncontrolled desires. We are reminded of the animal origins of calcium when we consider its greediness and it is this process that draws matter into the plant, filling it with substance and leading to a profusion of leaves and flowers.

This calcium process does not act alone but mediates the planetary influences of the Moon, Mercury and Venus. These planets supplement and modify the effects on Nature which come from the sun, and it is this combination of forces which works on all that is above the Earth's surface. These forces are mediated by calcium and work particularly into the inner force of reproduction and growth. These effects are climatically aided by the elements of water which, as we know from the tides, has a strong relationship to the moon. Thus a strong influence at the time of the full moon on seed germination is assisted by adequate rainfall or irrigation.

Calcium acts below the Earth's surface in the root sphere by stimulating the roots to grow in a finely branched manner in all directions. This is seen, for example, in the clover, with its finely ramified root system. Limestone acts here also to draw the warmth and air that are above the Earth's surface down into the soil, where they become inwardly enlivened. This inner living warmth in the soil is most active in the depths of winter. A more detailed description of this process can be found in lecture two of Rudolf Steiner's Agriculture Course.

The greediness of calcium that we saw in the properties of quicklime and slaked lime is also seen in the way the calcium can draw nitrogen into the soil. Although proteins are found in small amounts in plant matter (about 2 per cent), they are more predominant in animal tissues, for example, in muscle, bone and organ substances. While carbohydrates made of carbon, hydrogen and oxygen can be said to be typical plant substances (e.g., starches and sugars) it is the proteins that are more typical of animal substance, because of the much greater proportion in which they are found. In some plants, e.g., legumes, the protein content (about 20 per cent) is much greater than found in the plant world and when one observes this family, one finds certain animal-like features. These qualities can be detected through an artistic or meditative attitude that all farmers and gardeners should learn to develop.

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Thus nitrogen, which is drawn into the soil by limestone as an aspect of its craving nature, plays a more important part than is obvious to conventional science. In it is working the forces of soul - the astrality - which gives to us our emotions and feelings and to the animals their one-sided types of animality. This astral spirituality guides the forces of growth and development to connect themselves with the chemical structure of the plant skeleton which is provided by carbon. It is carbon that bears the creatively formative processes in Nature. As Rudolf Steiner noted in the third lecture of the Agriculture Course, 'Whatever in Nature is formed and shaped - be it the form of the plant persisting for a comparatively short time or the eternally changing configuration of the animal body, carbon is everywhere the great sculptor...Wherever we find it in full action and inner mobility, it bears within it the creative and formative cosmic pictures - the sublime cosmic Imaginations out of which all that is formed in Nature must ultimately proceed.'

This forming activity is of course supported by the silica and calcium processes with their differing effects. Opposed to this carbon process which tries to form the plant into a rigid structure is the force of the etheric, the life force, which, if allowed to develop unchecked, leads the plant to grow and grow in all directions to become swollen and formless. It is nitrogen, carried and held in the earth and in the plant world, which binds this life principle into the form or configuration embodied by carbon.

In the building of a biodynamic compost heap, plant matter with its etheric force is used together with ensouled animal manure. This is built into a heap with the right proportions of water and air. It is important that the life forces which are in the heap do not dissipate but become held and concentrated within the heap. These life forces are bound more strongly to the earthly carbon processes through nitrogen by the calcium contained in the plant chamomile. This is manufactured ion a special way as the compost Preparation 503. Calcium is also very important in the treatment of plant diseases in the form of oak bark (77 per cent calcium). Here the calcium in a living state can restore order when the vegetative forces are too strong. The plant will then develop luxuriant but weak growth and thus become subject to disease. In the biodynamic compost heap, oak bark is applied for this reason in the special Preparation 505.

As the part of Nature above the earth has a similar activity to our metabolic system, with its reproductive and digestive activity, so the processes beneath the earth's surface can be likened to the activity in our head. Here the roots search out water and nutrients like sense organs. Their very fine, hair-like structures remind us of the branching ramifications of our nervous system. Where the brain can be the bearer of thought and ideas, so this part of the plant and of Nature is also the bearer of the cosmic formative forces that guide the growth of plants into their specific and manifold shapes. It is in this area that silica unfolds its influence.

Whereas calcium mediates the earthly forces leading to growth and reproduction, silica opposes this tendency to give the plant form and structure. If there was only half as much silica in the Earth as there is, this form would be lost and the plants would become stunted and fleshy like cacti. The cereals would become thick and fleshy and would not be able to develop full ears of grain. On the other hand, if there was a lack of calcium with its ability to fill the plants with substance, the plants would be too formed, spindly and thin, like creepers. Calcium mediates the forces of the sun together with the Moon, Mercury and Venus, whereas silica is the mediator for the influences of Mars, Jupiter and Saturn, the most distant planets.

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Where calcium promotes an increased plant growth, these outer influences work in a more qualitative way, promoting the development of nutritive substance e.g., fruits, nuts, vegetables. Together with this are to be found an enhanced taste, smell and colour. It is no accident that those plants which are nutritious and also appealing to our senses of sight, taste and smell and are thus made more enjoyable by the art of food preparation. It is the silica process which gives us the capacity for appreciation of food through the stimulation of our senses.

While water is the element that enhances the inner planetary influences, spiritual science teaches us that it is the warmth element that has the strongest affinity to silica. Warm weather will thus enhance the effects of these distant planetary influences. These forces do not work alone into the nutritive value but also into the inner strength and form. Thus a pine tree planted in the right Saturn period will thrive differently and give off far more warmth when it is burnt than one planted at other times. The effect of this increased form on the plant's root system is to produce a strong tap root. This is especially strong in the coloured root vegetables such as beetroot and carrots.

The silica forces draw into the plant not only general forming forces but also those specific formative forces which give different plants their specific shapes. These impress themselves on the plant when it is most open to cosmic influences in the seed stage. At this time it is in the maximum state of disorder or chaos. This specific formative activity also gives the flowers their specific colour, e.g. all plants with yellow flowers are under the influence of Jupiter. All of these cosmic qualitative influences are taken up by the silica in the earth, especially in sandy soil, and are passed up into the region above the earth through the mediating effect of clay.

Where the soil is weak in silica, or an enhanced silica activity is desired, biodynamic agriculture has developed the horn-silica Preparation 501. If prepared properly and sprayed in the right conditions on a warm day, this will enhance the ability of the outer planets to produce above-mentioned effects.

Leitch, R., Chapter 16, *Biodynamics New Directions for Farming and Gardening in New Zealand*, Random House, New Zealand, 1989

Clay

Written by Andreas Welte

Clay minerals belong to a specialised group within the phyllosilicates or sheet silicates that can hold up to forty times the amount of water as their own volume by weight. This considerable level of expansion is largely due to exchangeable cations contained in the sample. Clays are usually a mixture of microscopic crystals of carbonates, feldspars, micas and quartz. The different minerals are polymorphous, which means they have the same chemistry but different structures. Their general structure comprises silicate sheets bonded to aluminium-oxide or –hydroxide layers in a lattice formation. Montmorillonite clays are notably layered silicates and are especially versatile as a catalyst for a series of organic reactions. Within the Smectite group of clay minerals, which includes Montmorillonite, we also find Algamatholite which has an aluminium layer sandwiched between two silicate layers. The aluminate can be released and counteracts fungal spores when used as a plant health promoter in Al 3 form.* In the Talcum formula Al 3 is replayed by Magnesium 3 to similar effect.

*Aluminium hydroxide

Sourced from Harvests, NZ BD Magazine, Vol. 59, No. 3, Dec 2007.

Silica: A Vital Element

Advances in plant nutrition research have led to a greater insight involving the role silicon plays in plants grown in soils, hydroponics or soil-less media. The following article has been put together by Steve Graham and features extracts of research done by the University of California, USA and the Pacific Agricultural Research Centre, Canada.

Silica or Silicon (Si) is a vital element for plant health and nutrition. A natural product, mined from fossilized fresh water algae, silica is the second most common element in soils next to oxygen. However, as plants extract silica, it needs to be replaced or plants will be susceptible to pathogens, fungal problems, slower growth and other health problems.

Silica strengthens plant cells and reduces fungal diseases, wilt, heat and cold stress, mineral toxicity, the effects of salinity and chlorine in poor water or soils. It also enhances pollen fertility, fruit and flower count and size, metabolic activity and flower colour.

Silicon deposits crystallize in the epidermal cells of plants and act as a barrier against penetration of invading fungi, such as powdery mildew and pythium. After infection of the leaves and roots, a greater deposit of silicon is found in the cell walls of the roots where it acts as a barrier against invasion of the stele by parasites and pathogens. Tests conducted on cucumbers, melons, strawberries, sugarcane and tomatoes determined that silicon is deposited very rapidly and must be available to the plant during the period of infection by the fungal spores.

Silicon is rapidly bound in leaf tissue and will be deposited in the cells wall with 24 hours. Continuous feeding with silicon is very important to combat pathogens. In most plants, foliar applications lead to lower rates of disease because deposits of silicon compounds on the leaf surface and promotes physical barriers in the infection process.

Research into silicon nutrition has shown that benefits include improved resistance to heat, enhanced leaf presentation resulting in greater photosynthesis efficiency, and increased reproductive growth (pollen fertility and flower and fruit count).

Research has also shown increased tolerance to excessive phosphorus, manganese and aluminum concentrations and zinc deficiencies. High and low temperatures cause plants to virtually cease their metabolic functions. Water loss through transpiration is faster than the root system can replace it. This creates harmful increases in the intracellular mineral concentrations that inhibit plant functions. Increased levels of silicon in cell walls reduce transpiration loss caused by higher temperatures. Plants wilt less, resist sunburn and are generally more tolerant of heat stresses.

Silicon deficiencies are often indicated by malformation of young leaves and a failure of pollination and fruit formation. In many cases, test plants fed with silicon have increased metabolic activity and chlorophyll levels. Leaves are thicker and darker green compared to those grown without Silicon.

Application of silica promotes enhanced growth in species as diverse as roses, hibiscus, camellia, gardenias, corn, ferns, citrus, orchids, strawberries, melons, tomatoes, barley, cotton, soybeans, cereal grains, sugarcane, zucchini and rice.
There is reason to believe that all plants will benefit from added silica, either as a soil conditioner or foliar spray or in combination.

BFA News, September, 2000

Using BD501

Using BD501 in the Home Garden

By Alan Johnstone and Terry Forman

Question. When is a suitable time to use BD 501 on a home vegetable garden with a wide variety of intermixed vegetable varieties growing?

Answer. There are three main cycles of vegetable growth during the year in most parts of Australia. 501 can be applied in each of these phases. Firstly there is the late winter/early spring phases when carrots are filling up and peas and strawberries are growing. Next there is the summer vegetable phase, when corn, zucchinis, tomatoes etc. are in abundance and then there is the autumn phase when the winter brassicas are getting established. The main thing to look for when spraying 501 is that the vegetables are not stressed e.g. don't spray 501 when it has been very dry and windy. An ideal time to spray 501 is when there has been a wet spell (often around full moon) and the vegetables develop lush watery growth. In these instances, 501 act as a balancing tool, bringing warmth and light back to the garden. Don't be dissuaded from using 501 if some of your vegetable are flowing and setting fruit. The flowers that are susceptible to being burnt by the 501 on the morning of spraying are more than compensated for by the improved quality of the vegetables that are already, or will consequently set fruit. Spray 501 on a fruit day in an ascending period or at Moon opposition to Saturn if the weather conditions are favourable. It is also worth considering organising your garden beds so that the vegetables you don't want to spray with 501 (such as lettuces in danger of going to seed) are separated from those you do want to spray. 501 is a very powerful preparation and tool for the biodynamic gardener who should experiment with its use and will greatly benefit from it.

It is suggested that stirring of 501 be done before sunrise and applied as the sun rises in a fine mist. If left too late in the morning burning of plants and skin can occur.

Applying BD501 to Hay and Silage

By Gareth Bodle

When paddocks are shut up for hay and silage, application of 501 during a water/leaf sign will tend to hold back flowering and bolting to seed, particularly of rye grass prior to cutting. A second application just as flower heads are starting to form reinforces this. If you are concerned about driving over paddocks that are ready to be cut for hay and silage it has been the experience of most farmers that the grass bounces back quickly with little or no adverse effect.

The other alternative is to drive around the paddock in the direction opposite to that which the mower will travel so that any flattened grass will eventually fall onto the mower blades rather than away from them. By taking these simple steps the amount of nutrition that can be retained in your crop is potentially significant as is the promotion of bottom growth in the crop.

The Compost Preparations

"How should we attempt to use the BD composting preparations creatively and productively in the extensive systems that characterize the Australian agricultural scene?" asks National Field Advisor, Terry Forman.

The bio-dynamic compost or manure preparations (502-507) have been very much under-utilized in Australia, especially when compared to the soil spray preparation (500). Perhaps this is not so evident at the garden or horticultural level but it is certainly true of the larger scale cultivation and grazing operations.

The main reason for this is probably that our extensive forms of agriculture – large areas, few people, all year round grazing – do not lend themselves to the practical collection of organic matter such as manure, straw and other crop wastes, which give an immediate and necessary environment for using the compost preparations. But the question facing us should not be whether we neglect the use of these preparations because we don't have intensive composting processes, but rather: "how should we attempt to use the preparations creatively and productively in the extensive systems we do have?" That is in systems that have the organic matter residues spread out over the paddock.

So far there has been little farmer motivation to take up this challenge. The BDAA at Powelltown (Alex Podolinsky, Victoria) has made 'prepared 500' (i.e. 500 with the compost preparations put into it) available to farmers. Although the practical benefits of such a simple compromise are obvious it hasn't allowed the farmers to develop an understanding of what they are doing with the compost preparations and thus there doesn't seem to have been any further progression.

However, more recently, following the lead of farmers in New Zealand, fish emulsion, liquid manures, and the Maria Thun cow-pat-pit have been tried as means of spreading the influences of the compost preparations. This is very encouraging because as farmers become more involved with the principles and practices of the compost preparations, then out of their own needs and knowledge they will begin to realize the potential of these preparations.

We have all seen how farmers have become great innovators with machinery as they have dealt with it over the last 50 years. They are often quite proud of their own 'patented' device for performing a given task. Indeed some have gone on to achieve skills in mechanical engineering which have significance in their own right. Perhaps in the next 50 years we will witness similar advances in biological innovation as more and more people acquaint themselves with the Bio-Dynamic method.

To give some idea of just what the compost preparations are, relative to the '500' and '501', I would like to use the analogy of a work of art. In this case a landscape, either as a black and white drawing using pencils, ink etc or an oil or water colour painting. The late Australian artist Lloyd Rees gives a very fine example of such a full range of landscape pictures. In his early drawings, merely pencil on paper, black on white, we see an exactness of detail, form, perspective, light and shade which is truly remarkable. The image can appear before us because of the contrast or polarity of dark pencil and light paper.

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In the Agriculture Course Steiner tells us how it is the fundamental polarity in existence, expressed as light/dark, sun/earth, levity/gravity, silica/limestone, summer/winter etc which is the real foundation of the planet's growth dynamic. The '500' and '501' preparations give us the potential to work into this polarity and thus produce a fine structured soil, well drawn plant growth and beautifully sculptured fruits and seeds. The grass family and the clover family also represent such a polarity (light/dark, silica/limestone respectively).

By adding colour to the picture however we are able to define the season, time of day and also our personal relationship to the landscape. Similarly on the farm when we begin manuring and composting we are adding the nutrient cycles of N.P.K. S etc, i.e. the "colour" to the form which is dynamic plant growth. In short if 500 & 501 are black and white, then 502 – 507 are the colours.

Just as there are certain laws of colour contrast and compatibility that the printer works with, there are also biological and chemical laws which govern the different nutrient cycles that the farmer works with. The compost preparations give us the potential to nourish and strengthen these cycles within the context of our own farm. They work at the level of the cycles or laws themselves which govern the movement of N.P.K.S etc, as they continuously merge and separate from each other.

The final result of all these organic matter processes which take place within the mineral realm of the soil is humus formation, and it is like and inner earthly flowering which results from the organized plant growth above the soil.

It really seems quite acceptable to common sense that the flowers, leaves and bark of plants, as well as the organs of farm and game animals, are the materials utilized in making the compost preparations and that such activity will increasingly find its place in the farm's biological workshop alongside the already well developed mechanical workshop.

In the Agriculture Course, Steiner also sets out the materials and methods for making the compost preps and their mode of working. In "Bio-Dynamics: New Directions for Farming and Gardening in N.Z." (Random House, Auckland, 1989) there is more detailed information on the preps themselves and the different methods of utilizing them which were mentioned earlier.

To complete the analogy of the landscape picture, it is interesting to follow Lloyd Ree's work from his drawings through his early oil paintings with their well defined bright colours and careful perceptions of the colours and shadows, on through his more imaginative pastel landscapes and then this later works where a few simple splashes of water colour and smudges of charcoal still unerringly and beautifully describe a particular landscape.

Terry Forman, *Newsleaf,* No14, Oct 1992, pp16-18

BD500 and the Cow Pat Pit

(also known as Manure Concentrate, Maria Thun's Barrel Compost and Birch Pit Concentrate)

By Terry Forman

The question of putting the "cowpat" preparation in with the BD500 preparation is characteristic of the very many questions we will have to face as we begin to bring our own intuition into cooperation with the broad brush principles and indications Rudolf Steiner gave back in 1924.

In the September Elementals, it was reported that an associate of Maria Thun (Wedig von Bonin) suggested that the cowpat preparation is connected with "decaying, composting process" and the "500 has to do with the incarnating plant" following on from the chaos of the germinating seed. Thus it is better not to apply them simultaneously.

This seems to contradict the advice and practice in New Zealand of mixing the cowpat preparation in with the 500 for the last 20 minutes or indeed mixing the compost preps directly with BD500. Similarly it's contrary to the making and recommended use of "prepared 500" (i.e. 500 having had compost preps inserted as compost) by Alex Podolinsky.

However this seeming contradiction need not, and certainly should not, leave us in a do nothing quandary. It is worthwhile remembering that the composting process is only half decay; the other half is formative.

Humus, the end result and principle goal of composting, does not occur in any plant or animal material, just as human tissue does not occur in what we eat. First comes the breakdown, decaying, digesting until chaos appears as an indeterminate midpoint. Then comes the formative, up-building, growing. The organs in our own bodies work in unison to order and *organise* the formative up-building *and* the excretive breaking-down processes. It is my feeling that the compost preparations (502 - 507) are working in a similar way.

Plant growth and organic matter processes are continuous and interwoven. I would think the 500 and cowpat preparations are complementary and could be mixed together in some way - at least until practice showed it would be better to do otherwise

However the possibility that putting too many things in together lessens their individual influence is quite valid - think of the water in which you wash your various coloured paintbrushes! The art is how you mix the colours and how you let them stand alone and that is quite individual and farming and gardening is after all, an art.

Terry Forman, Biodynamic Farming and Gardening Association, Armidale NSW
Elementals, Biodynamics Tasmania, Issue 19, 1991

Micro-organisms in the Farming System

The introduction of micro-organisms to the farming system (often termed functional or effective, beneficial or plant growth promoting organisms) is being widely researched. In the USA and Europe compost and composted manures amongst other things are used to introduce and maintain soil organic matter and soil micro-organisms. Effective micro-organisms are cultured by fermenting rice-based organic material. Other "inoculums" like compost teas and fermented teas (herb, seaweed) can be used in a similar way. Biodynamic preparations are at times included in this list.

Fresh preparation 500 is highly biologically active, as shown by various researchers in both New Zealand (van Steensel, 1995) and overseas (Pfeiffer, 1949). Van Steensel compared the biological activity (by means of respiration) between earthworm casts, rhizosphere soil, preparation 500, biodynamic compost, earthworm casts, commercial compost, rhizosphere soil.

He found preparation 500 to have the highest activity, followed by biodynamic compost, earthworm casts, commercial compost, rhizosphere soil.

Nutrient cycling and energy flows in terrestrial ecosystems are tied to the turnover of organic matter in soil. Although small in mass (we are still talking about tons per acre), the microbial biomass is amongst the most labile pools of organic matter and thus serves as an important and dynamic reservoir of plant nutrients. The succession of the soil microbial population during ecosystems development and soil development shows that simple food wed is vulnerable to external stress and largely based on a limited number of mainly bacterial species that build up a food source (humus) in the soil. Once the humus has reached a certain site specific level, the soil microbial population stabilises into a long term energy-efficient, harmonious, (semi) closed system and supports a mature or climax ecosystem. The soil food web structure has changed from being a relatively simple, vulnerable and bacterial based into a complex, stable community structure, rich in diversity and with an increased fungi population.

Review of New Zealand and International Organic Land Management Research, 2002, pgs 31, 32.

Tillage, Crop Rotation and the Application of Manure and Compost

The Three Elementals of Husbandry

The three elementals of Husbandry – tillage, crop rotation and the application of manures and compost – are highly interactive. They are more likely to create favourable growing conditions if the given characteristics of the soil in a particular field are taken into account when developing it beyond its natural potential to make it into good arable soil.

The aim of tillage is biological enhancement, i.e. to improve the balance of decomposition and synthesis, or of humification and mineralization and enhance productivity. It serves to improve the physical texture of the soil, stimulate the whole range of biological and chemical processes and create the condition of good tilth. In the final instance it is the biological activity of a soil that determines soil structure and its permanence and resistance of unfavourable influences such as heavy precipitation, the weight of machinery, and so on.

Tillage stimulates microbial activity and therefore humus decomposition and also causes temporary loss of soil structure as the natural soil stratification is destroyed. At the same time the chaos created in a previously well ordered system offers potential for heat, light, air and the influences of the cosmos as a whole, to intervene and establish new conditions. The weather is an agent capable of enhancing tillage effects. This is particularly important for heavy soils. Frost causes soil water to expand and break down large aggregates. Alternate wetting and drying of the land creates a layer of fine friable soil in heavy, plastic soils with high clay content.

On the other hand, very heavy rain leaches nutrients and colloids from cultivated fields, causes soil with high silt content to puddle and leads to erosion, which is also caused by wind. This kind of damage can be prevented by working the soil at the right time and not too frequently, creating the right surface profile, sowing catch crops to provide quick ground cover after working the stubble and applying as adequate amounts of organic matter (manure, compost) to stabilize the soil structure.

Tillage, crop rotation and the application of manure and compost are thus closely interrelated. These three basic functions of the farm organism combine to maintain and improve soil fertility and increase and safeguard good yields.

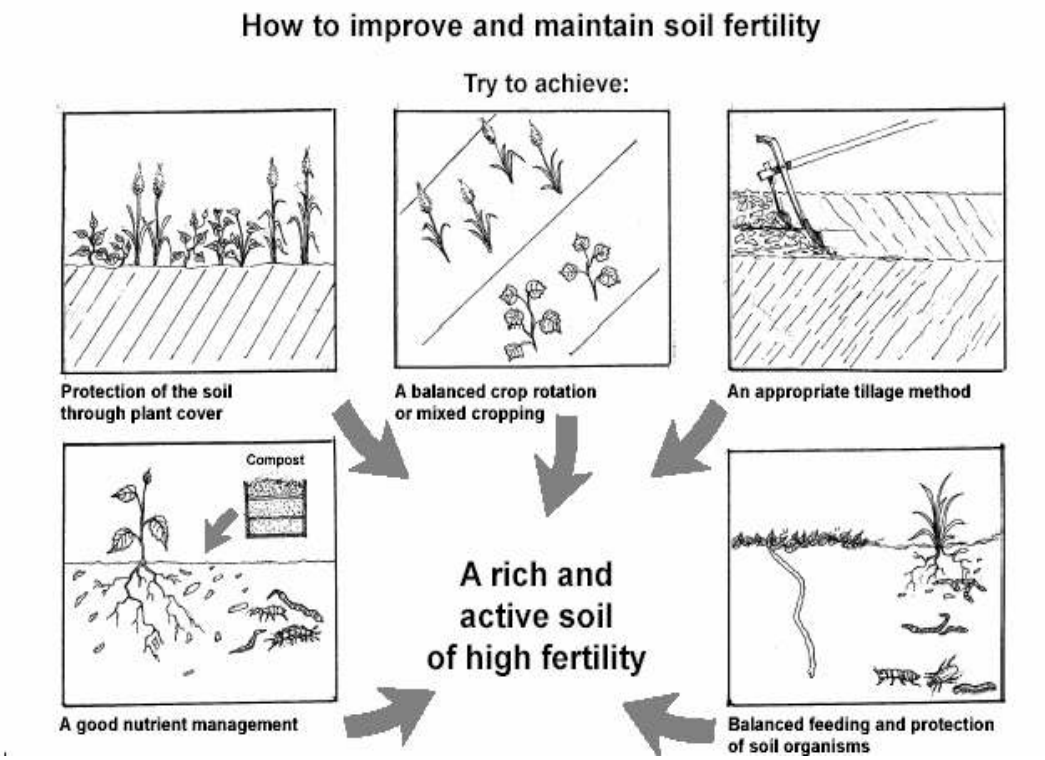
The Essence of Fertility

Permanent natural soil fertility depends on four elements working in harmony:

- The soil and its natural flora and fauna.
- A plant world where many different species and varieties share in the rhythms of the seasons.
- Animals with different needs for husbandry and feeding and with specific excretions.
- And human beings who bring all this together in such a way that a self sustaining unique individual whole is brought to life and can continue to live. Tillage composting and crop rotation are key factors in achieving this goal.

Sattler, F. & Wistinghausen, E, *Bio-Dynamic Farming Practice*, Cambridge University Press, 1989

How to Improve and Maintain Soil Fertility



IFOAM Training Manual for Organic Agriculture in the Tropics, 2003,
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Compost

Compost or Bio-Dynamic Compost by Hugh J. Courtney

The Autumn/Winter season is a primary compost making period for many bio-dynamic practitioners. Initially, my intention was to devote the article to the *how* of biodynamic composting, emphasising the less widely known "tricks of the trade". While I certainly hope to cover that aspect in the future, it has become increasingly evident that the more important topic to be addressed is the *why* of bio-dynamic composting.

This reorientation is prompted by the fact that so many people, including many professed biodynamic gardeners and farmers, do not seem to realize that a significant difference exists between biodynamic compost and ordinary compost. In questioning people as to whether or not their pile has had the biodynamic compost preparations in it, it was a this is probably that our extensive forms of agriculture – large areas, no, but it turned out all right anyway". From the non-biodynamic composter, my question was often answered by another question, "No, but what would B preps do that I am not getting out of my compost now?"

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To address these concerns and, more importantly, the attitudes which lie behind them, I would like to look first at composting as it is currently practiced. To begin with, the composter is encouraged to obtain a diversity of materials, with particular emphasis on ensuring a carbon to nitrogen ratio (C:N) of between 25:1 and 15:1. Often, small size particles of material are encouraged, even to the point of recommending that if you are serious about composting, a shredder is needed. Frequent monitoring of the temperature of the pile is also regarded as necessary, with special thermometers suggested to do this job. Beyond this, one is told to turn the pile often to keep plenty of air in it so that it will "break down" rapidly. The advice is often received from many quarters that "no inoculants or compost additives" are really necessary, as you can accomplish this for yourself simply by adding a little soil to the pile, or better yet, some compost from a previous pile. Such soil or old compost is deemed to contain "all the necessary bacteria" to break down the material in a compost pile. For large scale composting, the C:N concept is supplemented by a thorough chemical and/or bacterial analysis of various waste products (which are often waste disposal problems as well). This analysis permits the blending of the products in such a way that the best possible climate is created to encourage the proliferation of break-down bacteria and other organisms. With one or two exceptions, virtually nothing in the preceding summary of composting practices can really be objected to from a biodynamic point of view, rather than to recognize that all of the procedures indicated are intended to encourage "break-down". On the other hand biodynamic composting also includes a "building-up" process.

Let us now examine the attitude that a scrupulously honest look at the ordinary composting practices outlined above reveals. Many of the steps outlined above are simply manipulating material substance to achieve a mechanistic "break-down". The frequent turning recommended merely oxidizes the material, often into volatile gaseous compounds which waft off into the atmosphere. The composting process turns complicated, once-living organic compounds into simpler, chemical components that are no longer in a state or condition to emit offensive odours or appear visually objectionable. At the same time we will obtain a material that can bring certain fertilising components to the soil. In other words, our attitude with this approach is still somewhat orientated towards the chemical makeup of the compost by virtue of its nitrogen and other constituents. We are thinking in the same "NPK" terms that we find in mainstream chemical farming even though we can feel a bit better about it by claiming an organic label for our efforts.

If we adopt a Biodynamic perspective in our thinking, the one major change in our composting practices would be the use of the biodynamic preparations themselves. What is it that these preparations accomplish above and beyond the ordinary compost making process? Here we need to look at Rudolf Steiner's *Agriculture* course, most especially Lecture Five where he described the six biodynamic compost preparations to be used. In the process of manuring (in 1924 this word was virtually synonymous with the word "fertilizing" in today's language), Steiner stated: "- the etheric vitality must be retained within the realm of the living, - it should never leave the realm of growth". He further pointed out that in modern times, people have "lost all insight into how life that is common to plants and to the soil, also extends into the excretory products of life as we find them in manure." The task of spiritual science includes acknowledging the validity of scientific achievements. On the other hand it also includes active opposition to present day materialistic concepts when these concepts rest on totally false premises. As part of his acknowledgement of such achievements, Steiner referred to the "great deal" (that) has already been accomplished" in so far as the manner in which "manure, liquid manure, or compost should be prepared for use as a fertiliser." It should be noted that manure (compost) and compost are viewed as distinctly different in meaning.

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In 1924, and for some time afterwards, the word compost included vegetable matter, but not animal manures. It could, however, include dead animals. In 1990, we no longer define compost and manure so exactly, and the word compost is used loosely to cover both pure animal manures and pure vegetable composts, as well as all mixtures in between.

One of the quite specific false premises that Steiner himself focuses upon, is the idea that one can improve manure or compost by inoculating it with bacteria. The presence of this or that bacteria is merely a symptom of conditions within the pile at a particular stage of its "biography". Adding a particular bacteria to a pile in the beginning can be wasted effort, unless you have somehow managed to create the exact conditions within the pile for the bacteria concerned. This is highly unlikely because the bacteria associated with the "breakdown" being sought generally don't show up until after the normal stage of heating up that pile goes through when first built. Unfortunately, most of the consuming public can be approached more readily by referring to bacteria, than by mentioning biodynamic preparations and the forces they carry. Interestingly enough, Steiner actually suggests that we would be better off taking measures to combat the bacteria in our compost rather than using them to inoculate a pile.

A second false premise mentioned by Steiner deals with the practice of "treating the manure with all kinds or inorganic compounds and chemical elements". This practice rests upon a false premise, since such a treatment has no "Lasting positive effect" because it only affects the watery component of the soil. What biodynamics provides is a means to "properly vitalise" the soil or Earth element itself. The effect, or result, of present day "ordinary" composting is to reduce the various components to a mineralised state and, with luck, a certain humus fraction. This is why "ordinary" compost has so little carry over effect and why one has to constantly re-supply the soil with large doses of such compost. If that compost contains a large percentage of animal manure and if insufficient time is allowed for rotting, or break-down, the grower can expect an increase in pest problems. This is a major reason why it can no longer in good conscience be advised to spread raw manure on the land without first composting it thoroughly, (preferably by treating it with the biodynamic preparations in some form). An additional reason to avoid spreading raw manure is the often serious leaching of nitrates and other toxic compounds into the ground water. Well made biodynamic compost, using good quality biodynamic preparations, results in little or no leaching, and over a period of time, a substantial reduction in pest problems.

More importantly, the real purpose of the biodynamic preparations is summarized in the following words from Steiner:

"In order to grow sound and substantial plants, however, this (enlivening the water part of the soil) is not enough, because no further vitalisation proceeds from the water that seeps through the soil. We have to enliven the soil directly, and this cannot be done with mineral fertilisers, but only by means of organic material that has been conditioned to organise and enliven the solid earth itself. To indicate how this stimulus can be imparted to manure or liquid manure, or any other sort of organic matter, is the task of spiritual science with respect to agriculture."

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'Ordinary' compost works mostly through the watery element, and lacks the enlivening ability imparted to the soil by biodynamic compost. The remainder of Lecture Five contains the description of how to make these compost preparations which are the means to condition all organic material so that it (i.e. biodynamic compost) can *"organise and enliven the solid earth itself."* The preparations are the stimulants used to accomplish this enlivening process and 'ordinary' compost without the preparations lacks this enlivening ability. The biodynamic preparations give our compost the capability *"of infusing the manure with living forces, which are more important to the plants than the material forces, the mere substance."* 'Ordinary' compost only possesses substance, not the enlivened forces. That is why one must use the biodynamic compost preparations in making compost.

When looking at how one makes biodynamic compost, two key points should be foremost:

1. The preparations should go into the pile as early in the composting process as possible.
2. A biodynamic compost pile does not need to be turned unless it was not made properly in the first place.

Maria Thun in her book *Work on the Land and the Constellations,* pages 28 and 29 adds the following:

"We made compost heaps of comparable sizes, some without adding the compost preparations, others with them. It became evident even after a few days that there were marked differences. The prepared heaps warmed up during the week up to 26-30 degrees Centigrade depending on the kind of manure and after about ten days they showed a good amount of bacterial activity on the surface. They did not collapse but retained their shape. The heaps which had not been prepared heated up to 60-70 degrees Centigrade according to the type of manure. They omitted quite a lot of steam and one could tell by the smell that some volatile substances were escaping and that the heaps were sinking quite visibly. The remaining material was analysed and two months later new samples were taken for tests. It became clear that the prepared heaps were permeated right through with fungi showing that favourable processes of decomposition were underway, whereas the unprepared heaps showed a dry mould. We know that it takes many months for this to rot properly when it is worked into the soil. The tests demonstrated that the prepared heaps had a much better balance of materials. Two months later, further samples were taken. In the meantime the prepared heaps were permeated through with red compost worms. Only at the end of one year, did the unprepared heaps achieve a similar condition. The high temperatures at the beginning delayed the process of decomposition quite markedly and encouraged loss of substances."

References to Steiner Agriculture lectures refer to pp89-91

Newleaf, No.31, Autumn, 1997, pp 48-51

Life of the Compost Heap

When the gardener or farmer prepares a compost heap, he creates the general external conditions for the organic substances in which the elements earth, water, air and warmth can enter into a particular relationship to each other, so that an individual organism can be formed. The result is an entity which, although relatively autonomous, yet enter into various relationships to its surroundings. It can develop a life of its own. In farming and gardening, the fermentation process establishes the connection between the soil and the waste products of plants and animals. **The manure or compost heap can be seen as a newly created organ within the farm** If this organ is to function properly, certain outer and inner conditions must be met. A sample which the farmer takes from the heap, looks at, rubs between his fingers, smells, and perhaps even tastes, will tell him whether these conditions are being met. But not everything can be discerned from the outer features. One needs a far more detailed over-all picture. To this end, one can "extend" sense-perception by analytical methods, but small organisms in the compost may also serve as an indication. The compost heap offers only a very general outer structure. Its morphology shows us to what extent the earthly element has been lifted into the air. Perhaps we can still see something of the origin of the components, but its actual inner structure is hidden from view. **We can imagine the interior of the compost heap quite well by observing the animal life it contains.** The forms and behaviour of these animals bear relation to certain qualities of their environment. The presence of certain species of small animals indicates the presence of these qualities.

We shall here attempt to develop a general, versatile picture of the fermentation processes, which the farmer can use as a reference in training his observation. In accord with his own aims and experiences, he can, with the help of this general picture, direct the processes in one direction or another. For this reason we have consciously avoided giving "recipes".

The following examples are taken from experiments carried out over a ten year period, prompted by the questions:

1. What can we tell from the appearance and disappearance of different species of springtails (*Collembola* successions) during the course of fermentation?
2. How can we recognise the effects of the bio-dynamic compost preparations?

General picture of the development of a compost heap
If one considers the whole process with regard to the interaction of the elements, one finds, in the case of freshly heaped manure compost, a succession of four qualitatively distinct phases. Each phase is marked by the appearance of a new activity. The activities of previous stages are incorporated into the new ones, while surrendering their dominant functions. **In the first phase, the heap warms up. A kind of primal condition arises,** in which micro-organisms begin to proliferate in the break-down of organic substances. **The second phase, in which the quantities of micro-organisms and fungi increase, is characterised by an increased interchange with the air,** in oxygen respiration and in the escape of carbon dioxide and ammonia gas In this **phase of proliferating life,** the substances enter into new relationships with each other in the interchange with air. In addition, the C-N-ratio is reduced and the water evaporates. **The third phase is one of reconstitution. In this phase the transformation of substances takes pace in the fluid medium, more cut off from the surroundings.**

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It is a transitional phase from pure proliferation to an inner structuring of the solid element, the more highly organised animals take part most strongly in this phase, which can be characterised best by describing the way these animals appear. Species which are but little differentiated begin to proliferate. One species succeeds another by appearing, reproducing, and sooner or later, by disappearing. We have to do with a metamorphosis in time. **The character of this phase is akin to the water element.** In it the temporal context or the **context of change** is particularly active.

In the fourth and last phase a stabilising and structuring in the solid element is attained. This phase is the expression of an individualisation process. Activity which creates continuity reaches into the solid element. The **life context** is established.

The phases proceed very quickly at first and then increasingly slowly. On the whole, a picture emerges of an evolutionary process with the following stages: Saturn, Sun, Moon, and Earth, as described by Rudolf Steiner in *An Outline of Occult Science.* These descriptions, into which we cannot enter further here, portray a kind of archetype which can throw light on the specific processes of fermentation. Thus also the phases do not bear relation only to the elements. We can find connections in their chemical processes to:

- the **warmth ether** in the initial impulse and in the as yet uniform, indeterminate warmth structure,
- the **light ether** in the adjustment to the present spatial circumstances in the surroundings,
- the actual activities of the **chemical ether** in the progressive transformation of the heap, as it becomes more and more independent of its surroundings, and finally to
- the activity of the **life ether** in the structuring and individualisation of solid substances.

The effect of the Bio-dynamic compost preparations
Although the effect of the compost preparations is described in the agriculture course with reference to the soil and the plants, and not to the compost, we have nonetheless attempted to arrive at a picture of the development of compost with and without the preparation additives.

In the **first phase** the brief initial warming up of the heap was less intense, and afterwards the variations in temperature were generally more balanced. The temperatures from "within" and from "without" were closer together.

In the **second phase** the carbon dioxide and ammonia activities were different. On the whole, the meaning of these processes is the most difficult to understand.

In the **third and fourth phases** the *Collembola* populations were occasionally more numerous, and the species were often more constant. The formation of organically fixed nitrogen was more balanced and stable as a process. Also the C/N-ratio underwent less variation. In the end there was on the average 7% less loss of substance.

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Understanding the activities of the ethers in working with compost heaps
When the farmer prepares a compost heap, he can actually only deal with the solid and fluid elements. He incorporates air and warmth by combining the first two elements in such a way that greater or lesser numbers of fine air cavities are formed, and by giving the heap a size and density which allow the right warmth conditions to develop.

In the way the heap is prepared, the direction is given at the outset which will determine the whole subsequent development. The interrelationship of the elements and their activities is manifold. The fermentation must be adjusted to the influence of the periphery. The relationships at work in the periphery can also be described as etheric activities.

In working towards the right warming of the heap, which initiates the whole process of transformation, we are giving our attention to the activity of the **warmth ether**.

In choosing a location which provides the right conditions of sun or shade, which has adequate wind protection etc., we are giving our attention to the activity of the **light ether**. We are actually concerned here with the spatial situation, as far as we can understand it in the present moment.

The **chemical or sound ether** is active in the rhythms of the surroundings, in the course of the day and the year. In laying the heap we must take into account of the seasons, with their weather variations, as well as of the course of the day with its dew formation, light rhythms, temperature variations, wind, etc.

The **life ether** gives the life-context. Its activity gives a properly laid heap the possibility of developing a kind of life of its own.

We can therefore see three aspects:

- The physical conditions for the inner structuring of the heap are given through the activities of the elements
- In their interaction life appears in its etheric qualities
- They make it possible, through the variety of single, visible, natural beings, for something to become active which lives between them and to which they are subordinated.

This, therefore, is the ABC for our judgement of plant growth. We must always be able to say what in the plant is cosmic, and what is terrestrial or earthly. How can we adapt the soil of the earth, by its special consistency, as it were to densify the cosmic, and thereby hold it back more in the root and leaf? Or again, how can we thin it out so that it is drawn upward in a dilute condition, right up into the flowers, giving them colour- or into the fruit-forming process, permeating the fruit with a fine and delicate taste? For if you have apricots or plums with a fine taste-this taste, just like the colour of the flowers, is the cosmic quality which has been carried upward, right into the fruit.(Koberwitz, June 10 1924)

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The gardener or farmer learns more and more how to guide the life process of the compost heap. He also knows whether he has to turn the heap, in order to give a new direction to its development, or whether for the fertilisation of a particular soil he should interrupt the process at one stage or another. If he does this at the initial phase of development, the fermentation must be able to proceed in a modified form in the soil. The plant root then encounters the first proliferation processes in the heap. If, however, the fermentation is allowed to reach an advanced stage, the life of the soil and the inner formative forces at work there can become more stable, the organ "soil" becomes more durable.

Grass compost

In bio-dynamic agriculture the production of high quality fertiliser occupies a central place. The original material and its fermentation process is of fundamental importance in this. Owners of small gardens are not always in a position to acquire the necessary cow manure. They are compelled to purchase other materials. It is often possible, for instance, to acquire cut grass from parkland or orchard meadows. Similarly, the experimental garden at the Goetheanum has at its disposal large amounts of grass from the Goetheanum grounds; various questions arise. At what stage of development should the grass be mowed for composting? How do the marketed compost additives affect the quality of the grass compost?

What happens when compost is prepared from young, growing grass or from old grass in the summer stage of its growth? What effect do these composts have on cultivated plants? How are these processes modified by a mixed additive of lime, horn and bonemeal?

To answer these questions we must make the qualities of different fertilisers visible within an over-all context. Our starting point must be the character of the grass at different stages of growth. The whole process must be followed from the preparation of the compost to its application. Finally, the character of the fertilised plants must be studied.

Compost can be examined in a great variety of ways, e.g. through analysis, counts of micro-organisms, or the cultivation of plants. Nowadays many people are interested only in knowing how composts can increase the harvest. They give heed only to the findings of quantitative analysis. In his agriculture course, Rudolf Steiner throws new light on this problem. He describes in a special way the relationship between cosmic and earthly forces with regard to humus formation, plant development and plant structure.

The young grass on a meadow makes a fresh and vital impression. The plants still have before them quite varied possibilities of development. And if we follow the fermentation process of this young grass, we find this specific character in a slightly different form in the vigorous decomposition and humus-forming process. In plants fertilised with compost from young grass we find the same vitality, which then becomes transformed towards the flowering process where it appears outwardly in a richer abundance of flowers. At the same time the plants begin to wilt.

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Old grass on a meadow makes a dull impression, as of wilting and dying. The vegetation seems stiffened and its possibilities of development exhausted. This old grass decomposes slowly in a compost heap, and the whole fermentation process has a languid, hardening character in comparison to that of young grass. Plants fertilised with such compost appear old even at the beginning of their growth. They are never properly "young", for soon after germination they begin to show signs of ageing, like wilting leaves and slow growth. They only embody to a limited extent the structural possibilities of their species; their flowers and fruits are sparse. In this whole development, from old grass to plants composted with it, a more mineralising and dying element comes to expression; whereas in the development from young grass to the plants composted with it a more vitalising and harmonising element can be discerned.

Composts affect each plant species differently. For this reason the nature of the species must always be taken into consideration when fertilising.

In studying the character of different experimental plants, the following criteria were found most helpful. If we wish to examine the quality of compost we can either choose a plant which (like the radish) has a strongly vegetative character, and, depending on how strongly the compost stimulates the vegetative growth, develops more or less activity of its own, so that the characteristic form of the species is attained. Or else we can choose a plant (like the coriander) which is strongly connected to the cosmic forces and therefore reacts sensitively to over-fertilisation, which inhibits its development; wherever the cosmic formative principles are at work in the life processes of the compost, however, it attains to its full expression.

By "Goetheanism" I do not understand what Goethe thought up to (his death in) 1832, but something which, in Goethe's sense, can perhaps enter the thinking of the next millennium . This is what can develop out of Goethe's view of the world, is thought and his experience. (Berlin, August 6, 1918)

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Summary of the Course of Fermentation in Composted Manure

Two deviating courses of development, resulting from differing consistencies of the heap (looser and airier – compactor and damper) are here contrasted to that of a middle consistency.

1st Phase (Saturn)	2nd Phase (Sun)	3rd Phase (Moon)	4th Phase of Composting (Earth)	Transition into the soil as utilisation as fertiliser
Heat generation	Air activity	Fluid transformation	Inner structuring	
	Looser and airier			
			corresponds spatially to the tendencies of the upper layer of the heap	
Greater generation of heat	Less carbon dioxide and ammonia activity measurable in the samples. Very few mushrooms, but strong fungal growth in the form of "mould", often designated and combustion.	Very rapid proliferation of small animal organisms. A few species reproduce especially strongly and so remain dormant.	The further differentiation never gets full under way. The small animals predominate in an unbalanced way; there are no earthworms. The substances are more strongly mineralised (Nitrate formation!) and the organic constituents become a kind of torf-like, brownish raw humus. Reduced C:N ratio and greatest loss of substance.	Despite reduced C:N ratio this is not the best course of fermentation. The compost remains most stuck in phase 3 and from there there develops a stronger "dying" tendency.
	"middle consistency"			
			corresponds spatially to the tendencies of the middle of the heap.	

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1st Phase (Saturn)	2nd Phase (Sun)	3rd Phase (Moon)	4th Phase of Composting (Earth)	Transition into the soil as utilisation as fertiliser
Average heat generation, uniform warmth structure. Eggs and seeds of higher organisms perish.	Inner generation of gases, relation to the surrounding atmosphere. Increasing growth of microbes. Transition to fungal growth.	Continual transformation of the inner conditions. Appearance of single, simply structured species of small animals in mass reproduction. These succeed each other and check the proliferation of microbial fungus.	Here the differentiation, stabilisation and individualisation of the substances takes place. Many very differently structured small animal species, represented by smaller numbers of individuals, indicate the varied inner organisation of the heap, which is now in the solid substances as well. Numerous earthworms have appeared and have established an intimate connection to the earth. Together with the grey to blackish coloration, a smaller C:N ratio speaks for good, stable humus formation.	If the processes take place harmoniously, a slow transition occurs here to a living, well-structured soil.
	compactor and damper			
			corresponds spatially to the tendencies of the core of the heap	
Less heat generation	Greater carbon dioxide and ammonia activity in the sample points to more intensive proliferation of micro-organisms. Stronger growth of fungi, which reduce ammonia generation.	Here the animal life develops very slowly.	The transformation of the substances took place more and more on the level of phase 2. The heap differentiates. The small animals become more varied, but the earthworms are not so numerous. The processes stagnate somewhat in the compact wetness, especially in the core. The coloration can pass into greenish there. High C:N ratio, little nitrate formation, less loss of substance.	The substances are quite unstable. As soon as they are brought into closer contact with the air, new, rapid, conversion processes begin. Everything is still too "alive". The fertiliser can, under certain circumstances, provide stronger stimulation. But the losses can also be greater.

Ref: Biodynamic Agriculture - Koepf, Pettersson & Schaumann

Farm Scale Composting

By Ian Henderson

Composting on a farm scale is possible in Australia or New Zealand, even though the ready made collection of stable manure which results from housing animals through the long European winter, and which makes large scale composting an imperative there, is clearly absent. This lack of materials ready-assembled is the main argument usually presented for not being to compost on a large scale here.

On a mixed cropping farm it is certainly possible to assemble the ingredients. It is not difficult to make a wintering pad, on which cattle, standing on a litter of straw, can be fed. My particular yard holds 20-25 cows, and over 6-8 weeks in autumn they can produce the raw materials for about 150 tons of compost. Sufficient straw is added, usually every second day, to ensure that as much nitrogen as possible from the dung and urine is trapped. The cows become restless if the ammonia resulting from the volatilization of nitrogen becomes too strong (it happens in wet conditions), and an aid to stabilizing the nitrogen capture in such conditions is to spread rock dust and to inoculate the litter with the Bio-Dynamic compost preparations.

Feed consists of hay and silage, and a rubbing pole is provided since the yard is electrified. Electric fencing allows the yard to be easily opened up later to extract the manure.

The actual compost making uses a front end loader with a silage grab and a spreader wagon. The wagon mechanism is set going (but not moving forward), the material loaded in and as it is flung out by the beaters there is excellent chopping, mixing and aeration. A mound quickly develops, which can be turned into a windrow by shifting the spreader forward two to three meters each time the mound reaches a height of about two meters. Typically two windrows 45-50 meters long result, which then only require the addition of the compost preparations (one set every five meters) and thatching with straw before being left for the winter.

Turning the rows certainly speeds up the breakdown process, as well as helping to remedy moisture content problems (too wet or too dry), but in general I find the compost to be very usable with no further attention if it is not required until the following autumn.

Ref: BDFGAA, *Bio-Dynamic Resource Manual*, 3rd Revised Edition,
Compiled by Alan Johnstone, Pg 31.

A Well-tried Recipe for High Quality Compost

40% brown (hay/straw etc.)
35% green (preferably with soil clinging to the roots of plants)
15% manure (preferably cow)
5% clay
2.5% basalt rock dust and lime
Biodynamic compost preparations
65% moisture.

Farm Composting

If you are considering making compost on a larger scale the following information may help you in identifying machinery which can be used for larger scale composting operations. Success in proper composting of materials would depend however on prior preparation of the material;

- moistening carbon materials
- shredding coarse materials
- selection of the right ratio of coarse and fine materials to ensure proper structure and aerobic breakdown

"The actual composting at the end of winter uses a front end loader with a silage grab, and a spreader wagon (silage feed out wagon, or compost spreader with wings). The wagon mechanism is set going (the vehicle stationery), the material loaded in, and as it is flung out by the beaters there is excellent chopping, mixing and aeration. A mound quickly develops, which can be turned into a windrow by shifting the spreader forward two or three meters each time the mound reaches a height of about two metres. Typically, two windrows 45-50metres long are produced, which then require only the addition of the biodynamic compost preparations, and thatching with straw before being left for winter.
Turing the row spreads up the breakdown process, as well as helping the remedy moisture content problems (too wet or too dry).

Harvests, NZ BD Association, Vol 58, No. 1, p9, 2005.

Liquid Manure

Biodynamic Liquid Manures by Terry Forman

What is it?
Liquid manure is the substance which, for our purpose here, results from the fermentation of plant and/or urine or faeces coming from dairy or pig sheds etc. and also from chemical extracts, e.g. those obtained from treating seaweed with caustic soda (Sodium hydroxide) to make soluble the organic constituents.

There are two main types of liquid manures which are applicable in the Bio-Dynamic context. The first is made from farm sourced ingredients such as cow, pig, sheep or poultry manure and/or plant manure such as nettle, comfrey, thistle etc. The second is made from ingredients sourced outside the farm but within the biocycle of the farm's environment. In our situation, these are often fish and/or seaweed. Both types have a history of use in various farming and gardening cultures.

How is it made?
There are many recipes and techniques, but essentially it is made by adding water to the plant and/or animal material and letting the mixture ferment over a period of several weeks, often months. Sometimes, as in slurries coming from piggeries and dairies, no further water needs to be added. If cow, sheep, goat or poultry manure is collected then about five full buckets to a 200 litre drum is adequate. Then top up with water. Similar proportions can be used for fish and seaweed or kelp meal. Some practitioners prefer a stronger brew and dilute it further later, prior to application. If using fresh or dried green plant material such as nettles, comfrey etc. the drum can be filled right up and even packed down a bit before the water is added.

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The quality of water used should be such that it will not inhibit the biological fermentation. Some people think that rain water is best. Although the particular organisms such as yeast and bacteria which are involved in fermentation are mostly different to those that are involved in compost heap fermentation, there is still an ordered procedure at work and the principal aim is the same as making compost. We are trying to conserve some of the plant and animal formative forces by keeping them bound to the nutrients – although of course in a way that is quite different to when creatures were alive. And this is where the work of the compost preparations comes in.
The preparations 502-506 should be hung in the fermented liquid. To do this, make up a small wooden cross and hand the preparations, each wrapped separately in a piece of muslin (with a small stone for weight) from the four points and the centre. The cross can either sit on the edges of the drum or float in the liquid.
The 507 preparation (valerian) should be stirred as usual or added separately.
After several days, bubbling on the surface will show that the fermentation is underway. Stirring the mixture occasionally will also help promote the fermentation. The Virbella Flowforms have a particular application here.

Research done in Germany by Abele found in several years' trials, that addition of the compost preparations to liquid manure from cows and pigs together with aeration resulted in extensive stabilisation of odour, better tolerance in plants, increased root development and improved nutrient utilisation.

It is necessary to wait until the fermentation is mostly complete to get well balanced results in terms of soil development and plant growth. The time this takes will be determined by several factors, including the materials used, the temperature and the degree of aeration. It can be anywhere from a couple of weeks to many months.

How is it used?
The liquid manure will usually need to be diluted prior to application. A dilution rate of 10 parts of water to 1 part liquid manure is a good rule of thumb, however some products such as fish emulsion are diluted to a higher rate. Application can be via a watering can, a back pack sprayer or a tractor rig.

Of course, as well as being applied to crops, pasture or trees, liquid manure, undiluted makes a very useful addition to compost heaps.

What are the effects?
The following table gives some idea of the amount of dry matter (DM) and nutrients in several liquid manures as compared to chicken manure. The important point to note is that the actual amount of nutrients being applied with liquid manures is quite small, remembering that one cubic metre is 1000 litres or 200 gallons. Thus the recommended rates are only supplying a tiny part of the plant's requirements. It would be insignificant compared to the amount of nutrients coming from raw dung and urine on pasture or cropping land grazed by animals.

Thus the effects of liquid manures come from quite a different direction and are more acting as tonics or stimulants to the soil and plant processes. Their significant lies in the 'dynamic' forms in which the nutrients are present and also in the presence of physiologically active substances, which act more like vitamins or enzymes. They need to be thought of as aids to humus formation processes in the soil, not as replacements fro them.

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Hence they appear to have a particular role to play on farms converting to BD methods and where it is difficult to establish a mixed farm organism. They can be put alongside Maria Thun Cow Pat Pit in this regard.

	dil. cattle slurry 10% DM kg/m3	dil. Pig slurry 10% DM kg/m3	dil. chicken slurry 15% DM kg/m3	dry chicken manure 80% DM kg/t
org. DM	73	74	98	570
N	4.7	6.7	10.7	38
K2O	5.9	3.7	4.8	26
P2O5	2.4	5.8	9.5	39
CaO	2.5	4.5	16.0	52
MgO	0.6	0.8	0.9	6.6
Mn	0.02	0.03	0.06	0.24
Zn	0.02	0.04	0.05	0.24
Cu	0.005	0.028	0.009	0.04

Nutrient levels in liquid manures and dry chicken dung, with mean concentrations of dry matter (DM) (Vetter and Klasink 1973)
This whole area of manuring is one where farmers and gardeners exercise a good degree of their own initiative in making up brews which are individually suited to their own situations.

BDFGAA, *Bio-Dynamic Resource Manual*, 3rd Edition

Liquid Manure in a Biodynamic System

by Lynette West

I use liquid seaweed to distribute the influences of the biodynamic compost preparations as well as being a source of macro and micro nutrients.

In making biodynamic liquid seaweed I was very conscious of developing a liquid manure that stayed within the guidelines set down by Rudolf Steiner in his agricultural lectures.

The following is a description of the process which I use and the reasons for using this method.

Aerobic Breakdown
In making liquid manure the same principles apply as when making compost. All healthy systems in nature are aerobic, continually in the presence of oxygen. This principle applies to all composting systems, whether solid as for compost or liquid as for liquid manures.

To maintain aeration in the compost process fibrous materials are added when constructing the compost. To maintain aeration in a liquid manure process aerators are used to pump oxygen into the tanks twenty four hours a day. This ensures the process remain aerobic at all times

Chelation
Nutrients contained in seaweed are not in a form digestible to plants unless they are chelated. There are two chelating agents in nature; humus and aerobic bacteria. Aerobic bacteria are used to chelate the nutrients contained in seaweed making them plant available.

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Aerobic Bacteria
Over the years I have bred an aerobic bacterial base to chelate the elements contained in seaweed into organic molecules thus readily absorbed by the fine white feeder root hairs of plants. Through the chelating action of the aerobic bacteria, nutrients are now in the perfect form for a plant to utilise and have become part of a living organism.

The aerobic bacterial base is added to all batches of seaweed. This is used as a starter to each batch similar to what one would do when making sour dough bread. The liquid seaweed is quite 'alive' and often this 'bacterial base' rises to the top of the tank and the whole surface bursts into bubbles.

Plants Fed Naturally
In a Biodynamic system plants must be fed naturally through the fine white feeder root hairs. The challenge when using liquid manures is to avoid feeding plants directly through the water roots as is the case when we use artificial fertilisers. For a plant to feed naturally nutrients must be colloidally bonded to an organic molecule and must never pass out of this colloidal form.

Liquid Colloids
A colloid is a physical state of matter which can hold substances in suspension whether they are gas, liquid or solid. For a plant to feed naturally all nutrients must remain in this colloidal form. This is a most important factor in an agricultural system.

There is a great deal of difference between the development of fine white feeder root hairs from plants fed via water soluble fertilisers and plants fed via the colloidal system. Plants fed via the colloidal system will develop three to four times as many of the fine white feeder root hairs. This enables it to make entirely different use of the mineral nutrients and affects the whole health and vitality of the plant and the life of the surrounding soil. Nutrients in this form do not leach from the soil but are available when needed.

When we understand this important aspect of plant and animal nutrition we can see that there is a direct link between our health and our current agricultural practices. Human nutrition is linked to this process, we are not separate from it. We must understand processes in nature, based on the laws of life itself, which lead to this colloidal bonding of nutrients. This activity in Nature is performed by microorganisms and bacteria that live under aerobic conditions and which feed on organic compounds.

Biodynamic Compost Preparations BD502 to BD507
To ensure the process of converting all the macro and micro nutrients contained in the seaweed is guided in the right direction the biodynamic preparations (BD502-507) are added to the liquid. Whenever we breakdown organised material we enter the realm of chaos and it is here that these preparations find their realm. These compost preparations are quite specific aids and regulators, on the one hand they guide and support the breakdown process and on the other increase the plants receptivity to substances and forces coming from the cosmic environment.

Flowforms
Throughout the fermentation process the liquid seaweed is regularly flowed through a series of Flowforms; specifically designed vessels that simulate the vortical flow of nature. Flowforms move the water in a rhythmical chaos, vortical action. This action of the vortex puts an electrical charge on the particles of matter suspended in the water, in this case the seaweed, thus rendering them colloidal.

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Using Biodynamic Liquid Seaweed
The end result from this process is living bacterial liquid seaweed. Use of this liquid seaweed plays an important role in establishing and maintaining a healthy and vital environment that is rich in microbial activity. It is the ideal medium to get all the macro and micro nutrients contained in seaweed into the soil with no loss of nutrients.

Aerobic Breakdown

Benefits of using aeration pumps in liquid manures:

- provide extensive stabilization of odours
- better tolerance by plants
- increased plant root development
- improved nutrient utilization.

Anaerobic Bacteria

The following quotation is by Dr Elaine Ingham, Soil Food Web, Professor of Soil Microbiology and one of the world's leading micro-biologists;

"Anaerobic bacteria produce organic acids with a pH of 2. There is no plant that will grow its roots into this kind of acidity. That's why I talk about aerobic bacteria with a pH above 7. I talk about fungi with pH buffered between 5.5 and 7. How does a soil get below 5.5? Anaerobic processes - You're messed up big time when you see your pH go below 5.5."

Acres Australia, The National Newspaper of Sustainable Agriculture, Australia, April 2001, P39

Anaerobic and Aerobic Breakdown Processes

Research conducted by Greg Murphy, Hunter Valley Biodynamic Group, 2005

Research question
"Does the use of aerators change the Level and Quality of Nutrient Retention in Liquid Manures made out of Comfrey (Symphytum officinale)? Does maintaining aerobic conditions affect the time it takes to breakdown the plant material?
"A considerable number of liquid manures are made on our farm from various plants grown in and around the pastures. Comfrey has been chosen for the reason that it is a medicinal herb; according to Norrie Pearce, its qualities include phosphorus, calcium, iron potassium and sodium; and there is an adequate quantity of Comfrey grown on the farm which is available for this research project."

Process
"I provided two 160 litre plastic drum and added 5kg of freshly picked comfrey to each drum. I then added 100 litres of rainwater and 150mls of Manure Concentrate out of one of my cow pat pits. I stirred the contents of both drums and aerated one of the tanks with a fish tank aerator. Prior to covering the drums with shade cloth I found the pH to be 5 and the water temperature 50 degrees F. After one week I added a small set of biodynamic compost preparations to each drum. I also stirred both drums every week for 5 minutes."

There is a considerable difference in the pH, odour, colour and water temperature between the two batches; aerated and non-aerated. The following table shows the different outcomes from these two processes.

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Observations:
After one week

Non-Aerated drum				
pH	**Water temperature**	**Odour**	**Colour**	**Breakdown of plant material**
5.4	60^{0}F	Pungent		
Aerated drum				
5.8	60^{0}F	Little odour		

After two weeks

Non-Aerated drum				
pH	**Water temperature**	**Odour**	**Colour**	**Breakdown of plant material**
5.4	56^{0}F	Objectionable		Nearly all leaf material broken down except stems
Aerated drum				
6.2	60^{0}F	Sweet		Greater % of leaf and stem broken down

After three weeks

Non-Aerated drum				
pH	**Water temperature**	**Odour**	**Colour**	**Breakdown of plant material**
5.4	56^{0}F	More objectionable	Greyish/green murky colour	
Aerated drum				*Continued over page*
7.6	60^{0}F	Slight earthly smell	Clear and light straw colour	98% broken down of material

After four weeks

Non-Aerated drum				
pH	**Water temperature**	**Odour**	**Colour**	**Breakdown of plant material**
5.4	40^{0}F	Less pungent	Greyish murky colour	90% broken down of material
Aerated drum				
7.6	60^{0}F	Pleasant sweet smell	Caramel colour	98% broken down of material

Seaweed

"Consider that our blood contains all one hundred or so minerals and trace elements in the ocean. Seaweeds contain all of these in the most assimilable form because their minerals and elements are integrated into living plant tissue. In fact, as a group they contain the greatest amount and broadest range of minerals of any organism, and hence make superb mineral-rich foods. On account of this unusual mineral content, they are effective in relatively small supplementary amounts.

"As with land plants, it is important where seaweeds originate, because certain areas of the oceans are polluted, particularly with heavy metals. Since no body of water can now be considered as pristine, it is helpful to know that wherever seaweeds grow, they do not simple absorb and concentrate toxins. Rather they detoxify and transform a certain amount of toxic metals, converting them to harmless salts, which the body excretes through the intestines.

"In addition to a wealth of minerals, vitamins, and amino acids, seaweeds are especially excellent sources of iodine, calcium, and iron. A comparison of selected seaweeds in their customary dried state with other high sources of these nutrients looks like this; Hijiki, arame, and wakame each contain more than ten times the calcium of milk; sea lettuce contains twenty-five times the iron, hijiki eight times the iron, and wakame and kelp about four times the iron of beef; depending on when they are harvested, kelp, kombu, and arame contain one hundred to five hundred times more iodine than shellfish, and six hundred to three thousand times the iodine average of other marine fish."

Paul Pitchford, *Healing with Whole Foods*, p226, Third Edition.

Research Finds Seaweed Accelerates Chemical Breakdown

Scientists have found that the right amounts of powered seaweed accelerated the breakdown of the deadly insecticide DDT. Megharaj Mallavarapu, an associate professor at the University of South Australia, told the Sydney Morning Herald recently the right dose of seaweed caused 80 per cent of the chemical to vanish within six weeks.

"It works by helping micro-organisms in the soil to attack the toxin," he said. The organisms have enzymes that convert DDT into other substances that deteriorate quickly. The scientists' main hurdle was to build a big enough base of microbes to have a significant effect. They found that high levels of sodium in the seaweed dispersed clay in contaminated soil, allowing the micro-organisms to reach the DDT. "The sodium makes the DDT more accessible to the organisms," Prof Mallavarapu found that seaweed's high levels of carbon fed the micro-organisms, allowing their population to bloom, further aiding the breakdown of the chemical.

DDT was hailed as a wonder drug when it was introduced as an insecticide in the 1940s. It was used widely in Australia before being banned in 1987, but is still widely used in malaria-infested developing countries to combat mosquitoes. DDT was often used in Australia with another deadly chemical, arsenic. "In cattle dips they used arsenic and DDT together," said Prof. Mallavarapu.

"It is persistent in these soils because very high levels were used and the other chemicals in the mixture kills micro-organisms. "There are about 1600 cattle dip sites in the country still contaminated with DDT," he said. Prof Mallavarapu was one of several scientists working on DDT contamination with the CSIRO, Flinders University in Adelaide, the University of Adelaide and University of Newcastle-upon-Tyne in Britain. The scientist who suggested using seaweed was Professor Ravi Naidu, a Research director at the University of South Australia.

Crop Rotation

If annual vegetable crops are grown in the same place year after year, there is a risk that soil borne pests and diseases will become a problem, and that plant health and vigour will decline. A better system is to move crops around the growing area. This ancient practice, known as rotation, continues to be used today to the benefit of both soil and plants. Plants which belong to the same family are grouped together when planning a rotation.

Related crops are prone to the same soil-living pests and diseases - and moving them around in an organised rotation helps to prevent the build up of problems in the soil.
Some plants are better than others at suppressing weeds. Alternating crops helps to keep weeds under control.

Sourced from Garden Organic: http://www.gardenorganic.org.uk/

Managing Crop Rotations

In rotation design you aim to:

- balance cropping, which generally robs the soil of some fertility, with legumes and green manures, which build fertility
- include plants with different rooting systems, shallow versus deep, fibrous versus tap-rooted
- include legumes which are essential*
- separate plants with similar pest and disease susceptibility by appropriate time and physical gaps. Rotate weed-susceptible crops with weed-suppressing crops
- use green manures to minimise the time the soil is left uncovered, especially during the months when the most damaging rain occurs
- maintain or increase organic matter levels and biological activity in the soil.

Once a good rotation is developed it is not applied rigidly from year to year. It is adjusted to suit the needs of seasons and demands of markets, while maintaining a long-term view of the fertility of the soil and the needs of the crops and animals. This may mean robbing the soil fertility in the short term with a high-yielding crop and restoring it in the long term with the rest of the rotation.

*Without the assistance of the leguminous plants in the crop rotation the biodynamic methods are fruitless. With their assistance it is possible to guard against reversion and failure, to counteract the stimulating effect of mineral fertilisers, and at the same time prepare for new life activity in the soil.

Ehrenfried Pfeiffer, *Using Biodynamic Compost Preparation and Sprays in Garden, Home and Orchard*, p46.

Technical Notes for Crop Rotations

- Crops must be suited to your soils
- Design crop rotations to meet the residue needs of your crop residue management plans
- Rotations that include small grains or meadow provide better erosion control
- Small grains and meadow can always be used to replace any row crop or low residue crop to gain better erosion control.

Corn (grains) can always be used to replace soybeans or any other low residue crop in the rotation to gain better erosion control
For crop rotations which include hay (meadow) the rotation can be lengthened by maintaining the existing hay stand for additional years
Avoid planting a grass after a grass if possible.

Sourced from internet site *Core 4 Conservation for Earths Future*

Benefits of Crop Rotations

- helps sustain the farm or garden
- beneficial to the overall health of the soil
- improved soil tilth and aggregate stability
- helps to balance nutrition within the soil
- avoids one-sided cropping which exhausts the soil
- builds up soil fertility
- slows down humus depletion in the soil
- rejuvenates soils
- avoids one-sided cropping which exhausts the soil
- increasing species diversity with in the soil
- avoids disease build-up
- controls weed growth
- reduced insect and disease problems
- interrupts insect pest cycles
- reduced insect and disease problems
- soil water management
- reduction of soil erosion
- reduction of allelopathic or phototoxic effects.

General Effects of Crop Rotations

One immediate economic benefit of crop rotations is improved yields. For example, sunflower yields over eight years at Crookston, Minnesota were often significantly greater in rotation with other crops than when continuous sunflower was grown (Table 1). Wheat yields were also greater with rotation than continuous wheat in an eight-year study conducted with different crops at Fargo (Table 2). A study at the Agriculture Research Service at Mandan has shown that increased hard red spring wheat yields can be expected when an alternative crop is included in the rotation.

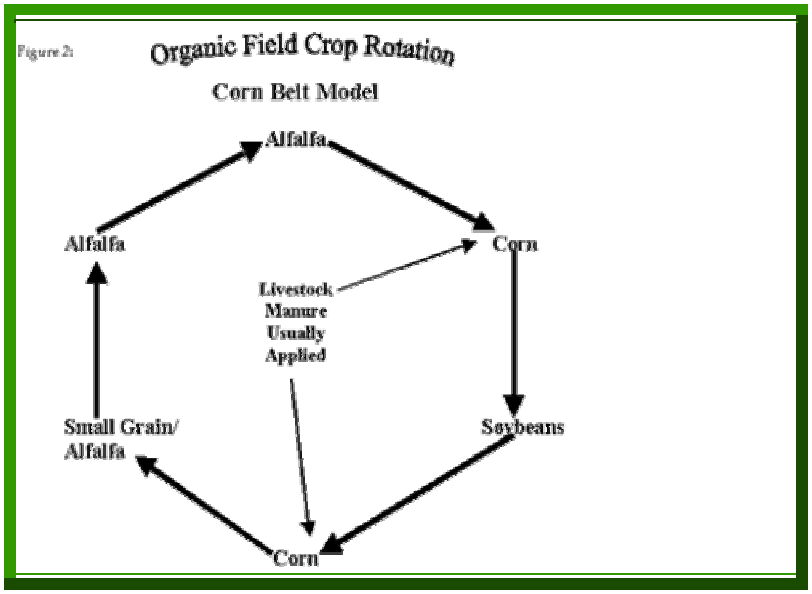
Table 1. Yields of sunflower following sunflower and in rotation with other crops at Crookston, MN.

	Sunflower yield, lb/A				
Previous Crop	1973	1975	1977	1978	4 yr Avg
Sunflower	852	1338	1852	1781	1456
Potato	908	1279	2348	1605	1535
Sugarbeet	770	1683	2358	2168	1745
Pinto Bean	946	1410	2282	1674	1578
Wheat	1284	1549	2339	1655	1707

Planning Crop Rotations

Essentially a tool for annual cropping systems, crop rotation refers to the sequence of crops and cover crops grown on a specific field. Particular sequences confer particular benefits to long and short-term soil fertility, and to pest management.

Agronomic operations are especially dependent on crop rotations that include forage legumes. These provide the vast majority of the nitrogen required by subsequent crops like corn, which are heavy consumers of that nutrient. Even when livestock enterprises are present to generate manure, the animals are largely recycling the nitrogen originally fixed by legumes in the system. An example of a basic agronomic rotation, typical of that found on Midwestern organic farms, is shown in Figure 2.



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The basic Midwestern rotation demonstrates the elegant way in which a whole farm system can be derived and function: Legumes fix nitrogen in the soil, providing for subsequent non-legumes in the rotation.

Several insect pest cycles are interrupted, especially that of the northern and western rootworm species, which can be devastating to corn. Several plant diseases are suppressed, including soybean cyst nematode. Weed control is enhanced as perennial weeds are destroyed through cultivation of annual grains; most annual weeds are smothered or eliminated by mowing when alfalfa is in production.

Livestock manures (if available) are applied just in advance of corn, a heavy nitrogen consumer. All crops can be marketed either as is, or fed to livestock on-farm and be converted into value-added milk, meat or other livestock products.

Ralph and Rita Engelken, widely respected organic pioneers in the 1970s and 1980s, used a similar rotation that suited their hilly northeast Iowa farm and supported their main livestock enterprise—backgrounding beef cattle. (Backgrounding is confined or semi-confined feeding of young range stock to increase their size before final finishing in a feedlot.) The feed ration the Engelkens relied on consisted mostly of haylage, corn silage, and ground ear corn. The 6-year rotation/crop mix that allowed them to produce virtually all their own feed on 410 acres was:

oats/hay → hay → hay → hay →
corn → corn → [cycle repeats] (17).

Table 2. Effect of previous crop on wheat yields, Fargo, ND

	Wheat yield, bu/A-Conventional tillage								
Previous Crop	1977	1978	1979	1980	1981	1982	1983	1984	8 yr. Avg.
Wheat	22	26	35	37	34	39	43	16	31
Barley	27	25	35	37	42	46	48	18	35
Flax	31	37	36	35	37	47	43	37	38
Corn	31	32	43	37	45	53	39	38	38
Soybean	42	43	42	42	46	49	54	45	45
Sunflower	29	33	44	41	45	39	43	44	40
Sugarbeet	34	34	41	38	44	43	52	47	42
Average	31	33	39	38	42	44	46	35	

Rotating to a different crop such as wheat on barley ground usually results in higher grain yields when compared to continuous cropping of wheat. Even greater benefits are usually obtained by rotating two distinctly unrelated crops, such as a small grain seeded into land where the previous crop was a legume or other herbaceous dicot such as flax or sunflower (Table 2). Many of the reasons for the beneficial effects of rotations are not completely understood.

Source: *Miscellaneous Report* 166 - 1979, AES, University of Minnesota.

Guidelines for Crop Rotations

In rotation design you aim to:

- balance cropping, which generally robs the soil of some fertility, with legumes and green manures, which build fertility
- include plants with different rooting systems, shallow versus deep, fibrous versus tap-rooted
- include legumes and non legumes
- separate plants with similar pest and disease susceptibility by appropriate time and physical gaps. Rotate weed-susceptible crops with weed-suppressing crops
- use green manures to minimise the time the soil is left uncovered, especially during the months when the most damaging rain occurs
- maintain or increase organic matter levels and biological activity in the soil.

Once a year good rotation is developed it is not applied rigidly from year to year. It is adjusted to suit the needs of seasons and demands of markets, while maintaining a long-term view of the fertility of the soil and the needs of the crops and animals. This may mean robbing the soil fertility in the short term with a high-yielding crop and restoring it in the long term with the rest of the rotation.

NSW Agriculture, *Ecology for Organic Farmers*

Home Gardening, Horticultural Enterprises

Incorporate as effectively as possible the guidelines as give below:

- Root plants generally do better in lighter soils
- Fruiting plants enjoy the benefits of compost applications prior to planting
    - with the exception of tomatoes which prefer compost applications the preceding year
- Onions often are not helped when they follow a leguminous green manure
- Carrots, beets and cabbages are generally detrimental to subsequent crops.

Cropping, Grazing Enterprises

Incorporate as effectively as possible the guidelines as give below:

- Avoid planting grass after grass
- Cover crops can help in the rotation
- Legumes fix nitrogen in the soil, providing for subsequent non-legumes in the rotation
- Cell grazing is a form of crop rotation
- Crop rotation cycle can be lengthened through maintaining a hay crop for additional years.

Planning a Rotation

Rotation plans in gardening books tend to be based on standard British crops - brassicas, legumes, potatoes and so on. Even if you don't grow any of these, you can still devise an effective rotation that suits you and your crops. The usual length is 3 or 4 years - so crops return to their original site after a break of 3 or 4 years. If the soil is already infected with persistent problems such as eelworm or clubroot, try to extend the rotation of susceptible crops even further.

List all the vegetables you want to grow over a season, and the relative quantities of each. Remember to include green manures. Group plants together by botanical family. Some relationships may seem a little unlikely, but if you were to let all the plants flower, their family likeness would soon become clear.

Draw a plan of the growing area. Divide it into **equal sized** sections according to the number of years you want the rotation to last - try 3 or 4 to start with. A "section" may be made up of several discrete areas, or you may have several "sections" in a large bed. Distribute your crops within these sections.

The first rule is to keep families together; if a section is to hold more than one family, try and keep those with similar growing requirements together. Using a bed system can planning a rotation easier. You may also find it helpful to write crops on to pieces of those moveable sticky note pads. You can then play around until you find a combination that fits.

You may find, for example, that the quantity of potatoes you had planned, might be too large to fit a section. In this case, reduce the number of plants rather than abandoning the rotation. Short term crops such as lettuce and other salads, early carrots and beet can be fitted in on any plot. Keep records - of what actually happened, not just what you planned! Use this information when planning the next year's cropping.

Sourced from Garden Organic: http://www.gardenorganic.org.uk/

Examples of Crop Patterns

The following patterns come from talking to scientists, other growers and from the list that Eliot Coleman identified in the "New Organic Grower". Biodynamic farmers have a rule that goes as follows: Fruit - Leaf - Root (Tomatoes - Salad - Carrots).

- Mustard is beneficial before a tomato crop (we incorporate it in the green manure)
- Legumes are generally beneficial preceding crops.
- Lucerne has many beneficial effects over and above the fact that it is a deep rooted legume.
- Onions, lettuces, and squashes are generally beneficial preceding crops
- Potatoes yield best after corn.
- For potatoes, some preceding crops (peas, oats, and barley) increase the incidence of scab, whereas others (soybeans) decrease it significantly.
- Corn and beans are not greatly influenced in any detrimental way by the preceding crop.*
- Liming and manuring ameliorate, but do not totally overcome, the negative effects of a preceding crop.
- Members of the chicory family (endive, radicchio, etc.) are beneficial to following crops.
- Onions often are not helped when they follow a leguminous green manure.
- Carrots, beets and cabbages are generally detrimental to subsequent crops
- Cabbages suppress germination in the soil that they are growing in.

*Mycorrhizal fungi colonize all of one row crop, mustards excepted. Plants such as cauliflower, broccoli, the mustards and brassicas all reject mycorrhizae. That is why corn can't follow broccoli in a rotation. The broccoli will have annihilated the required mycorrhizae.

Taken from Acres USA, January 2006, p19

Crop Rotation Examples

Example of a six year rotation scheme for cool climates.
The annual garden is divided into six areas of 10sq. metres each and the following plantings made:

Bed A:	Solanums Plant tomato, capsicum, chilli, eggplant and basil in Nov/Dec, harvest until the first frost in Autumn when it becomes bed B
Bed B:	Alliums Plant spring onions, shallots and garlic in late Autumn Plant the main onions (early and late varieties) in Winter Plant more spring onions in early Spring and plant leeks in late Spring The garlic and onions are all harvested by February/March and in Autumn snow peas and broadbeans are planted and it becomes bed C (although the leeks are still there until Winter)
Bed C:	Legumes Plant snow peas and broadbeans in Autumn, plant more snow peas in Spring Plant peas in Autumn or early Spring Plant climbing beans in late Spring and bush beans successively through the Summer The peas and broad beans are finished by Christmas and are replaced from mid Summer with Autumn and Winter salad leaves which are harvested until Spring when it becomes bed D Any empty space is filled with green manure in Autumn
Bed D:	Brassicas Plant broccoli, mizuna and lettuce varieties in early Spring Plant cauliflower, more broccoli, swedes and turnips in Summer Plant rocket, mizuna, mibuna, pak choy and Chinese cabbage in early Autumn Cabbages and Brussels sprouts would be included in this bed but they can be omitted The crops in this bed are harvested during Autumn and Winter and in Spring it becomes bed E (some late cauliflowers may still be there in early Spring)
Bed E: (half)	Root crops, silverbeet spinach and potatoes Plant carrots and beetroot in Spring and again in late Summer, harvest from Summer until Winter Plant silverbeet in Spring, harvest until the following Spring, Plant spinach and more silverbeet (for the chooks during Winter) as space becomes available in Autumn Celery would be included here if you wished to grow it
Bed E: (half)	Plant potatoes in Sept/Oct, harvest Feb/March Follow the potatoes with green manure, dig in in Spring, it all becomes bed F
Bed F:	Curcubits and sweetcorn Plant zucchini, cucumber, pumpkins and sweetcorn in late Spring/early Summer Plant green manure in Autumn, dig it n in early Spring, and it becomes bed A

This plan can be easily changed to a 5 year one by omitting the winter salad in bed C and the spring brassicas in bed D. If this is done bed C then becomes bed D from Summer until Spring (with the beans remaining until Autumn) and the legumes, brassicas, roots and potatoes have all rotated through in two years rather than three.

Again this is only one of many possible rotation plans and could easily by adapted to include a different combination, or different relative quantities, of vegetables.

Adrienne Fazekas, *Canberra Organic,* August 2004 p.14,15

Eliot Coleman's Vegetable Rotation

The following table gives the rotation that works very well for Eliot Coleman in the colder part of the USA. It is being applied in many parts of Australia with similar benefits. Whether it works for you depends on your situation and on you. Even if it doesn't suit your style of farming, you can certainly use the principles to help you design a rotation for vegetable or broadacre cropping.

Note: The table has been adjusted for Australian conditions.

Eliot Coleman's Vegetable Production

Year	Crop	Coleman's reasons
1	Squash	Squash is grown after potatoes in order to have the two 'cleaning' crops back to back before the root crops, thus reducing weed problems in the root crop.
2	Root crop: beet, carrots, parsnips, turnips	Root crops follow squash and potatoes that are good 'cleaning' crops (they can be kept weed-free easily). So, there are fewer weeds to deal with in the root crops, which are difficult to keep weed-free. Squash has been shown to be a beneficial preceding crop for roots.
3	Beans	Beans follow root crops because they are not known to be subject to the detrimental effect that certain root crops such as carrots and beets may exert in the following year.
4	Tomatoes	Tomatoes follow beans in the rotation because this places them four years away from their close cousin, the potato and gives them good nitrogen.
5	Peas	Peas follow tomatoes because they need an early seed bed, and tomatoes can be undersown to a green manure crop that is susceptible to frost. The frost kills the green manure and then it lies on the surface and provides soil protection over winter. There are no decomposition and regrowth problems in the spring.
6	The cabbage family	The cabbage family follows peas because the pea crop is finished and the ground cleared by February 1, allowing a vigorous winter green manure crop to be established.
7	Sweet corn	Sweet corn follows the cabbage family because, in contrast to many other crops, corn shows no yield decline when following a crop of brassicas. Secondly, the cabbage family can be undersown to a leguminous green manure which, when turned under the following spring, provides ideal conditions for sweet corn.
8	Potatoes	Potatoes follow sweet corn in this rotation because research has shown corn to be one of the preceding crops that most benefits the yield of potatoes.

Ecology for Organic Farmers, NSW Agriculture

Green Manures

Benefits of Using Green Manures

- increasing organic matter
- building soil structure
- pest, weed and disease control
- take up soil toxins.

Selecting Criteria for Green Manure Plants

Using plants that are:

- suitable to local conditions
- identifying the growth rates of each species
- fit into the crop rotations used
- plants used are in accordance with required outcomes and production requirements
- do not harbor pests and diseases which can be transmitted to crops grown
- can be grown with minimal labor and water
- determining the availability and price of seeds.

Establishing Green Manure Crops

- preparing land suitable for planting
- sowing seeds of green manure plants thickly
- maintaining plants until just before flowering except for nitrogenous plants which should be cut between flowering and setting seed.

Guidelines for Use of Green Manure Crops

Green manure crops are used to provide bulk organic matter which is then converted into humus. Green manure crops should be incorporated into the top soil and immediately sprayed with C.P.P. Enough time must be allowed for the complete breakdown of organic material prior to sowing. Time required for the complete breakdown of organic matter will depend upon;

- temperature
- soil moisture
- growth and species of plants used
- C:N ratio of plant material
- biological activity of the soil.

Timing

Incorporation of green manure crops and spraying of C.P.P. should be carried out during the afternoon periods and when there is moisture in the soil.

Land area required

Planning to improve the organic matter content of soils over a 5 year period.
Planning to be based on 5 year rotation
100% ÷ 5yrs = 20% per year
20% @ average 4 months per green manure = 7% under green manure at any given time

Calculations based on green manure crop growth 10 weeks, decomposition time 6 weeks.

Continued over page

Guidelines for Incorporating Green Manure Crops

- incorporation of green manure crops into the soil:
    - before flowering but while still actively growing
    - from two to six months depending on what plants were grown
- green manure crops are incorporated into the top layer of soil:
    - in heavy soils crops are dug into the top 5-15cm of soil
    - in lighter soils crops are dug into the top 10-20cm of soil
- young green and fresh plants can be dug directly into the soil
- bulky plants with higher carbon structure will need to be finely chopped before being incorporated into the soil
- care needs to be taken to avoid damage to soil structure
- to avoid structural damage choose times of moist soil conditions
- establishing of plants following the use of green manure crops only when the green manure has been fully decomposed.

Green Manures

Humus is built up and maintained in permanent pasture by rotational grazing, sheet composting of animal manures (harrowing of cattle manure, natural breakdown of sheep manure) and spraying once or preferably twice a year with 500 (500 with the 6 compost preparations incorporated)*. On dairy farms, where manure can easily be collected, BD compost can be applied in rotation, with great benefit, over a period of time. Permanent pasture is the best developer and maintainer of soil structure and fertility.

In orchards, grasses and their roots are kept active by slashing at the right stage – allowing the pasture top grow up to an optimum height and slashing before it stagnates. From time to time, leguminous green manures can be grown in orchards to provide additional nitrogen, disced slowly (max. 3km/h) and shallowly in, or slashed, when ready.

In vegetable growing, humus levels soon become depleted. Colloidal humus can be supplied through compost if enough is available, but usually green manure crops are grown to restore humus and nutrient levels for subsequent crops.

Green manures are crops that are grown specifically to build humus and nutrient levels for subsequent crops (or in the case of orchards, to supply nitrogen). A wide variety of plant species are suitable for use as green manures, and the more species grown together, the better. Legumes and non-legumes, deep and shallow rooting, each species brings something different to the soil. The superb market garden, Agrilatina, near Rome, uses up to 94 species in its green manure crops.

Soil Preparation

Soil can be cultivated if necessary, using tyned implements (or gently disced) or, on a small scale, a garden fork. Avoid over-working the soil. For many species of green manure, a fine seed bed is not necessary.

Sowing

On a small scale, seed can be mixed and hand broadcast, later raking or harrowing in to lightly cover it.

Continued over page

Alex Podolinsky, in Biodynamic Agriculture of the Future, describes his advice to Agrilatina (Italian market garden): "I further suggested, after cultivation, to sow down the green manure, to irrigate no deeper than ten centimeters and to walk out prepared 500. This brings the plants up and is followed by a second ten centimeter irrigation. The plants will come up twenty centimeters high. This is followed by one very deep watering, easy to achieve in a sandy soil, which in turn then dries off from the top downwards. The roots stimulated by the prepared 500, follow the water deeper and deeper and the 500 activity therewith acts and structures deep into the subsoil. After four weeks the soil can thus be penetrated to one meter.

"It is easy to achieve soil transformation in the topsoil region, but we must strive for depth activity...". Compost, even if of really developed colloidality, and, as usual, put into the topsoil, draws the roots to the enriched soil at the top. The effectiveness of sheet composting and what we achieve, especially with our dynamic rotational grazing management, works deeply into the soil."

Working the Green Manure in

The crop can be worked into the soil at any stage, but best when there is a good bulk of material, and before stems become too tough. For many crops, the best time is just as the first flowers open. On a small scale, the crop can be scythed or mowed and left to wilt for a few days before forking it in. I use a hand scythe, and cut the crop down in several stages starting at the top, to cut it into smaller pieces. This makes it much easier to dig into the soil. Dig the garden fork in full depth, carefully lift the spit of soil and turn it upside down. Most of the green manure material on the top will then be incorporated into the soil. On a larger scale, the green manure can be chopped up with a mulcher or shallowly (25-50mm only) rotary hoed to break it up. Alternatively a slasher can be used. The ideal is to work it in with a chisel plough after a few days wilting – this is feasible if the crop has been chopped finely by a mulcher, but otherwise the tynes may block up. Discs may then be a better option. It is best not to incorporate the whole crop in one go as this can lead to anaerobic breakdown and leaching of nitrogen. Alex Podolinsky recommends that the first chiseling leaves between 10 and 30% of the material on the surface. A subsequent chiseling a week later (if conditions are suitable) will incorporate most of the remaining material. Just after the first ploughing, spray prepared 500* to assist in the conversion of the green manure into colloidal humus. In some situations, where seasonal conditions are tight, a BD farmer may have to use a mouldboard plough to quickly incorporate a heavy green manure crop, chiseling after the subsequent vegetable crop to break up the "table-top" under the soil and prevent a hard-pan developing.

Allow sufficient time for decomposition before planting – this will depend on the time of year, weather conditions, plant species, growth stage and the amount of material incorporated. Normally, at least three weeks should be allowed before planting, but check progress by digging.

* Applications of Manure concentrate at this stage would greatly enhance the breakdown process.

Biodynamic Growing, Bio-dynamic Agricultural Association of Australia No.5, Pgs12-15

Organic Matter

The Value of Soil Organic Matter

- source of food for soil micro-organisms
- provides materials required for production of soil humus
- higher soil temperatures due to darker soils
- biological activity is sustained by soil organic matter
- lowers dependence on inputs.

Practices Which Increase Soil Humus Levels

- applications of compost as required to all areas under production
- allowing good plant root development before grazing/slashing
- harrowing of manure followed by applications of compost preparations
- incorporation of all plant and crop residues followed by applications of compost preparations
- beneficial soil cultivations
- use of crop rotations
- use of green manure crops and cover crops
- use of legumes to increase soil nitrogen
- use of rock dusts applied through biological mediums
- establishing deep rooting perennial plants for pastures
- regular use of the full set of biodynamic preparations
- balance in areas such as stocking rates, grazing and cropping land
- increase in the diversity of soil, plant and animal life
- grazing management systems which maintain good root development in plants such as cell grazing
- judicial short term use of lime, gypsum, dolomite to balance soil pH
- ensuring good protection from the elements
- use of correct rhythms in all farm or garden activities.

Practices Which Support Conversion of Organic Matter into Humus

- regular applications of the biodynamic preparations
- several green manure crops in succession
- incorporating crop stubble
- regular mulch mowing of pastures
- harrowing manures
- intense short term gazing with heavy stock numbers (refer here to Holistic Resource Management; Alan Savory)
- deep ripping to increase aeration and soil biology.

Note: Each of the above activities followed immediately by applications of manure concentrate and/or liquid manures

The Benefits of Soil Organic Matter

The list of benefits from having organic matter in soil is so varied and extensive that it makes one think of the clams printed on old-time patent medicine labels; fortunately, those for organic matter are all true:

1. Organic matter is the source of 90 – 95 percent of the nitrogen in unfertilised soils.

2. Organic matter can be the major source of both available phosphorus and available sulphur when soil humus is present is appreciable amount (about 2 percent or more).

3. Organic matter supples directly, or indirectly through microbial action, the major soil aggregate-forming cements, particularly the long sugar chains called polysaccharides.

4. Organic matter contributes to the cation exchange capacity, often furnishing 30 – 70 percent of the total amount. The large available surfaces of humus have many cation exchange sites that adsorb nutrients for eventual plant use and temporarily absorb heavy metal pollutants (lead, cadmium, and the like), which are usually derived from applied waste waters. Adsorption of pollutants helps clean contaminated water.

5. Organic matter commonly increases water content at field capacity, increases available water content in sandy soils, and increases both air and water flow rates through the soil. This latter effect is probably due mainly to soil aggregation, which produces larger soil pores.

6. Organic matter acts as a chelate. A chelate (key-late) is any organic compound that can bond to a metal (usually iron, zinc, copper, or manganese) by more than one bond and form a ring or cyclic structure by that bonding. The soluble chelates probably help mobilise these micronutrients, increasing their availability to plants and general mobility in soils. The chelate mechanisms are not fully known at present.

7. Organic matter is a carbon supply for many microbes that perform other beneficial functions in the soil. (e.g. free nitrogen fixers, denitrifies).

8. When left on top of soil as a mulch, organic matter reduces erosion, shades the soil (which prevents rapid moisture loss), and keeps the soil cooler in very hot weather and warmer in winter.

   But wait a minute! The news about OM isn't all good. Read on!

Some problems with OM

Organic matter can be an energy and carbon source for many disease organisms, ensuring their longer survival in soils. Also residues from incorporated green manure crops can hinder easy planting of a following crop.

Both of these problems are overcome when the organic matter is supplied as compost. A growing body of research is showing that the diverse soil biological activity promoted by compost leads to balanced situation when disease organisms are held in check.

Excerpted from *Soils* by Donahue, Miller and Schickler, Prentice Hall NJ 1983
Newsleaf, Journal of BDAA (Australia), No. 14, 1992

Carbon Sinks and Organic Matter Levels

Carbon sequestration (where minerals are locked up into plant tissue, preventing them from leaching into the soil), has the effect of reducing levels of atmospheric carbon dioxide by 'tying up' carbon in organic matter and is commonly seen as relating to trees absorbing carbon dioxide from the atmosphere.

However, all plants 'sequester' carbon when they photosynthesise. The Canadian government is reported to have published research on the potential for carbon sequestration in the soil through farm management practices like stubble retention and by arguing that vegetative organic matter in the soil is a carbon sink as long as the levels of organic matter are retained.

Humates

A humate is a salt form of humic acids. "Humus is the organic matter of soils that has decayed sufficiently to have lost its identity with regards to its origin. The most important and biochemically active group of many degradation products of soil organic materials is the alkalisoluble fraction commonly called the humic acids. The salts of these humic acids are known as the humates. The ability of the humates to poise or regulate water-holding capacity or content is probably their most significant property so far as agriculture is concerned, since from a quantitative point water is the most important plant material derived from the soil. In conjunction with this water regulating effect, the humates possess extremely high ion exchange capacities, and it is this property that makes possible better retention and utilization of fertilizers by preventing excessive leaching away from the root zones and ultimately releasing them to the growing plants as needed.

The humates reduce soil erosion by increasing the cohesive forces of the very fine soil particles. The desirable friable character of fertile soils is maintained through the formation of colloidal mineral complexes, which assist in aeration and prevention of large clods and stratification. Very low concentrations of purified humates have been shown to stimulate seed germination and viability, root growth, especially lengthwise. Significantly increased yields have been reported from many crops, such as cotton, potatoes, wheat, tomatoes, mustard, and nursery stock. They have also been shown to stimulate growth and proliferation of desirable soil microorganisms as well as algae and yeasts. A number of workers have reported that the humic acids can solubilize and make available to plants certain materials that are otherwise unavailable, such as rock phosphates. The humates seem to play an important role in plant utilization and metabolism of the phosphates. The humic acids apparently can liberate carbon dioxide from soil calcium ca**rbon**ates and thus make it available to the plant through the roots for photosynthesis. The humates are known to stimulate plant enzymes. The humates are nature's soil conditioners par excellence. (Humate materials are also known as Leonardite).

Harvey Lisle *The Enlivened Rock Powders*, p98,
Everette M. Burdick in Economic Botany

The Wonderful World of Humus and Carbon

Web site link: http://humusandcarbon.blogspot.com/

Effects of Soil Humus on the Environment

(Fulvic Acids Role)

Soil humus has three important components that play a crucial role in the life of the soil: Humic Acid (soluble composting function), Fulvic Acid (soluble mineral transfer function) and Humin (non-soluble soil amender). While the Humin is non-soluble and remains in the soil, Humic and Fulvic acids enter the plant as the plant uptakes nutrient.

Fulvic acid is a chelator, which means it binds with metals, being trace minerals, within the soils. It alters the form of the metal from its elemental state into a chemical state we call a "phyto" or plant derived state. In simple terms it binds the mineral with a carbon and allows it to be readily absorbed by the plant or animal. This is the form we receive our trace minerals.

Fulvic acid is an extremely strong chelator and binds with differing elements in unique ways. If a metal is important in the food chain (i.e. Copper, iron, zinc, etc.) fulvic chelates that metal and places an electrostatic charge on the metal ion so that it readily enters the food chain. Some metals such as lead, mercury, etc. are toxic to most living organisms. Fulvic acid also chelates these metals, but places a neutral charge on the metal ion that deters its entrance into the food chain. This is Mother Nature's way of protecting living cells from toxins within the soils. Research has indicated that as long as we have about 2% soil humus within the soil sufficient fulvic acid is present to filter toxins out of the food chain. Unfortunately, past and current farming practices have depleted much of our farmable soils of its humus contents.

As an example of what is occurring, consider that for 70 years our country burned leaded gasoline within our fuels. This pollutant, in trace amounts, spread across the surface of our country and in effect raised the background level in our soils. Without sufficient soil humus containing the fulvic acid, lead is entering the food chain. Granted it is in extremely small amounts, but it and other similar toxic minerals can be cumulative and over a period of years can and will effect the health of plants and animals.

I have addressed what happens during the mobility of the chelated trace mineral, but what happens to them as they reside within the soil. Fulvic acid, in conjunction with humic acid, binds the minerals to the clays within the soil. This tends to prevent leaching into the ground waters and streams. Dr. Peter Warwick with Lethbourgh University in England has been researching the chelating ability of fulvic acid to bind and hold radioactive isotopes in the soil. Dr. Warwick is the radiation safety officer for the European Super Collider in Belgium and is many times asked for remediation solutions to real and postulated radiation contamination resulting from the Super Collider activities. He and his staff have studied the soil and use fulvic acid as a chelating agent within the soil to immobilize the contaminant. Just immobilizing the contaminant is not the total remediation answer. How long is the chelation stable and how immobile is the contaminant? No one knows for sure, but computer models developed by Dr. Warwick's group predict the chelation is stable for many thousands of years provided there are no drastic changes in pH. The fulvic acid places the contaminate into a state that is non soluble and bound to the clay particles of the soil. Due to its neutral charge, it cannot chemically react and therefore is effectively immobilized.

Although we are not dealing with radioactive isotopes in our farming soils, we do have toxins within those soils in which the same chemical interaction is occurring. Fulvic acid is Mother Nature's environmental protection agency and when our soil humic is low, we are not receiving the protection.

Another issue related the fulvic acid along with it counter part humic acid is regarding non-metal and organic loadings within the soil. There has much in the news of nitrate and phosphate run-off depleting oxygen within our stream waters. Additional organic overloading from large animal confinement areas has created similar water quality problems. Both are a function of the soil humus not containing sufficient amounts of humic and fulvic acids to handle the problem. Recently I was in a meeting with a local county commissioner discussing this problem. A planned housing development is being platted in a rural area on a 120-acre pasture. This farm had been used for hay production and was fertilized several times annually. For hypothetical purposes lets assume the farm was fertilized with 200 lbs per acre for a total of 24,000 lbs of chemical fertilizer on each application. This fertilizer loading created some run-off. Now consider the development plans call for ¼ acre home lots creating 480 new yards and flowerbeds surrounding each home. Typical homeowners will fertilize more often and with greater loading to create the "green look". Assuming each homeowner puts 50 pounds on the front yard and 50 lbs on the back yard, the total fertilizer loading for the 120-acre tract is now 48,000 lbs.; double the problem. Additionally, each home will have a septic system. This development will create 480 septic tanks placing additional organic loading into the ground, which eventually migrates into our streams and lakes.

Our soils in these rural areas are depleted in humus and do not contain sufficient humic and fulvic acid to handle the increased pollutants associated with urban sprawl. No programs are in effect to assist or educate the homeowner or farmer in rebuilding his soils. Currently Texas law does not permit county commissioner's court to address zoning in the rural areas, therefore this problem is only going to become more intense.

There is no "silver bullet" that is as easy solution to the problem, but growing organically and using natural materials to rebuild the soils is a big start in addressing our soil and environmental problems.

Soils Alive written by Randy Mosley, Enviromate Inc.
The third of a series of six articles defining the importance of soil humus.

Manures

Results from Using Raw Manure as a Fertiliser

- depletion of oxygen in the soil as the manure requires oxygen to break down into plant food
- oxygen deficiency means anaerobic breakdown, which favours plant diseases
- volatile nitrogen (ammonia) and soluble nitrogen (primary nitrates) are produced by the breakdown of manure in the soil. If these are present in quantity, they stifle or burn fine feeder roots of crops plants
- since weeds often can tolerate more abuse than crop plants, this condition favours weeds, especially the tall ones
- soluble nitrogen compounds leach into the water table and lower water quality
- increases the presence of harmful microorganisms and parasites
- limited market as produce handlers usually will not buy crops if they know they have been fertilised with raw manure
- excess nitrification in plant
- raw manure fed crops tend to spoil more quickly and to taste bad
- plants tend to be low in sugar and deficient in silicon, calcium and either important 'hard' nutrients
- makes plants subject to insect attack
- produces sicker plants than salt fertilisation, despite adding organic matter and micronutrient factors to the soil.

Human Manure

Human manure should never be used for food plants until it has undergone composting. Manure from humans would be permeated by the ego forces. This manure must be completely broken-down before it is suitable for use on food plants.
The break-down process would need to include;

- Green manure crop which is sprayed with manure concentrate when it is turned-under.
- Pasture cycle on which animals are grazed (astral forces).
- Manure harrowed and sprayed with manure concentrate to build humus.

This process takes the human manure through the etheric, astral and physical kingdoms.

Soil pH

It is reasonably common knowledge that the pH scale is that by which the acidity or alkalinity of a solution is measured: pH 7.0 representing neutrality, lower values acidity, and higher ones alkalinity. Litmus paper is a universal colour indicator for pH. [Its active constituent, litmus, is a plant pigment extracted from lichens, (a symbiotic union of an alga and a fungi) which are increasing in importance and interest in today's world because of their sensitivity to pollution.]

Soils with a pH range below 6.0 or above 8.0 lock up most of their nutrients into forms that make them unavailable to plants, which is why the use of artificial (soluble-salt based) fertilisers and over-liming usually only serve to aggravate the problem.

For example, take phosphorus: Some minerals are relatively insoluble in medium acid soil conditions. Aluminium and manganese are two which combine with phosphorus to form poisonous compounds when acidity increases. Plants are drastically weakened by taking up these compounds. When over liming occurs, phosphorus combines with aluminium and iron in a form useless to plants.

David Guiness, *Newleaf*, Journal of BDAA, Australia, Dec 1994

Testing Soil pH Using pH Tester

Measurement of pH in soil is very common as it affects the relative availability of soil nutrients. If the pH is not within an acceptable range, growth will be curtailed and erosion potential is increased. The ability of the soil to provide adequate nutrition to the plant depends on four factors:

- the amount of various essential elements present in the soil
- their forms of combination
- the processes by which these elements become available to plants
- the soil solution and its pH

The amount of various elements present in the soil depends on the nature of the soil and on its organic matter content since it is a source of several nutrient elements. Soil nutrients exist both as complex, insoluble compounds and as simple forms usually soluble in soil water and readily available to plants. The complex forms must be broken down through decomposition to the simpler and more available forms in order to benefit the plant. These available forms are summarized in Table A. The pH value is a measure of acidity or alkalinity. The effect of pH on availability of essential elements is shown below.

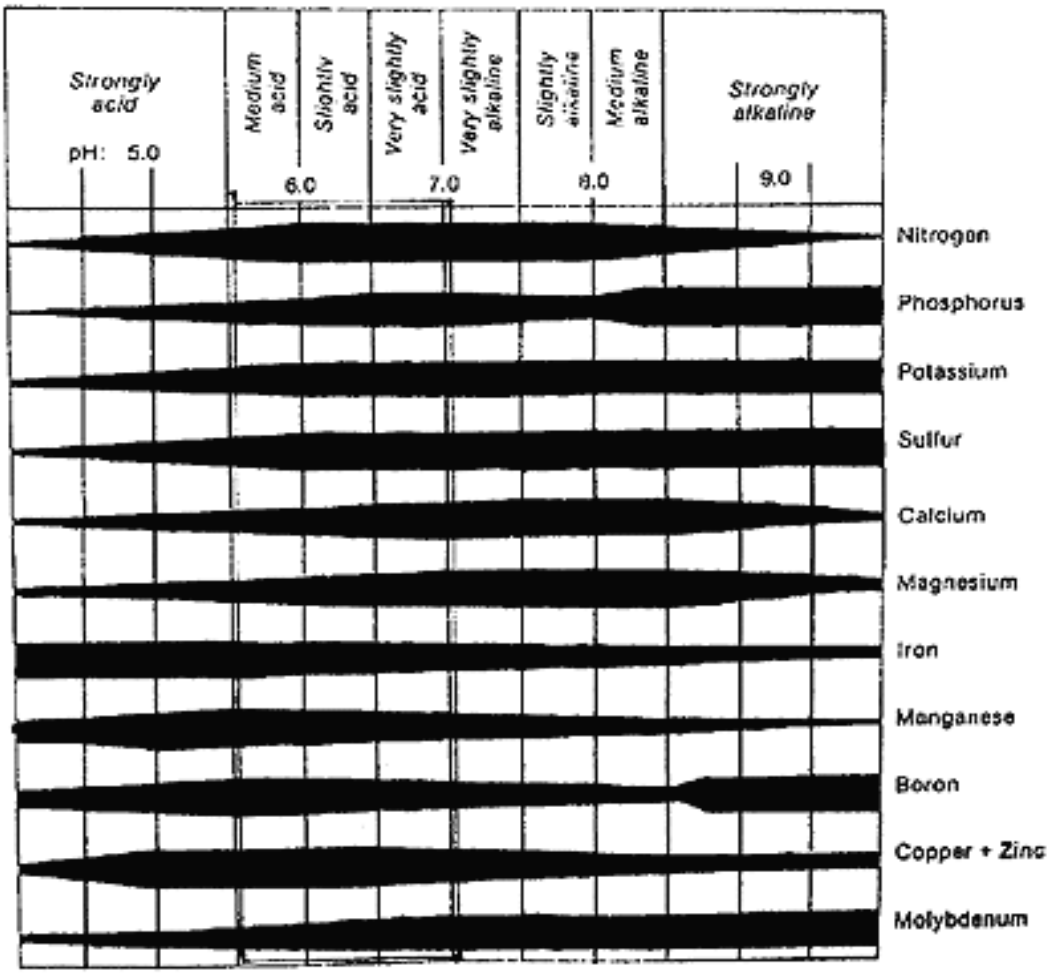

Table A The effect of soil pH on availability of plant nutrients (From Hunger Signs in Crops, edited by H.B. Sprague, 1964, pg. 18)

Iron, manganese and zinc become less available as the pH is raised from 6.5 to 7.5 or 8.0. Molybdenum and phosphorus availability, on the other hand is affected in the opposite way, being greater at the higher pH levels. At very high pH values the bicarbonate ion (HCO3) may be present in sufficient quantities to interfere with the normal uptake of other ions and thus detrimental to optimum growth. When inorganic salts are placed in a dilute solution they dissociate into electrically charged units called ions. These ions are available to the plant from the surface of the soil colloids and from salts in the soil solution. The positively charged ions (cations) such as potassium (K+) and calcium (Ca2+) are mostly absorbed by the soil colloids, whereas the negatively charged ions (anions), such as chloride (Cl-) and sulphate (SO4-) are found in the soil solution.

Soil Sample Preparation

1. Scoop up loose soil samples with a clean, dry plastic jar. Avoid touching the soil with your hands to prevent contaminating the sample.
2. Remove any stones and crush any clumps of soil to prevent breaking the delicate pH Meter glass electrode bulb.
3. Fill up your sample soil up to 3/4 and add distilled water to the jar. Cap the jar tight and shake it vigorously a few times. Let the mixed sample stand for 5-10 minutes to dissolve the salts in the soil.
4. Prepare to log your test result in your data book for later reference.
5. Remove the caps of the jar and your pH Meter. Dip the pH Meter electrode into the wet soil slurry and turn the tester on. Take the reading when it stabilizes.
6. Press HOLD button to freeze the displayed pH measurement. Record the pH reading in your data book.
7. Press HOLD button again to release the reading.
8. Rinse your pH Meter tester in clean water between each use.

Calibrate the pH Meter tester using the instruction provided in the packaging box.

Soil pH Data from pH Meter

The pH test value in this procedure is accurate to ±0.5 pH or better (usually ±0.2 pH). The soil sample preparation and test procedure is adapted from accepted laboratory methods. Soil pH testing in the field gives small differences between tests. Using the 0.1 pH resolution pHMeter 1 minimizes these differences. Most soil pH measurement cannot achieve ±0.1 pH accuracy, even with elaborate laboratory procedures and expensive pH instruments. Usually, soil pH data for many applications do not require testing for better accuracy than a few tenths of a pH or ±0.5 pH in some instances. pHMeter 1 easily meets requirements for soil pH testing, and is very economical to use in places where many samples and tests are taken.

Use of Data

Use this soil pH test data when consulting with authorities from your local agricultural extension office, local growers associations, university agronomy/agriculture on soil pH. You must consult these agencies before putting chemicals on soil to correct soil pH, and for finding the cause of soil pH problems. You can consult reference books, papers and pamphlets.

Recommendations for Best Results

Prepare and run at least three tests of the same soil sample to confirm results. Minor (< ±0.5 pH) or no differences between readings indicate good technique and high confidence in results. Larger differences (> ±0.5 pH) require more testing and consulting with the authorizes mentioned above. Compare your test results with secondary soil pH references available from these test authorities. Confirm good technique and accuracy of your test results with these agencies.

Sourced from http://www.eutechinst.com/techtips/tech-tips5.htm

Macro Elements and Micro Nutrients

Macro Elements
Macro elements are 'bulk' substances. The main bulk of plants in volume and weight is comprised of them.

Macro Nutrients	Chemical Symbol	Ions Used by Plants
Hydrogen	H	
Carbon	C	
Oxygen	O	
Nitrogen	N	NO_3^- (nitrate), NH_4^+ (ammomum)
Potassium	K	K^+ (potassium ion)
Calcium	Ca	Ca^{++} (calcium ion)
Magnesium	Mg	Mg^{++} (magnesium ion)
Phosphorus	P	$H_2PO_4^-$ (orthophosphate, dihydrogen phosphate), HPO_4^- (hydrogen phosphate)
Sulfur	S	SO_4^{--} (sulfate)

Micro Nutrients
Trace minerals are defined as those elements present in soils in amounts of less than 0.1% by weight. 60% of all trace elements are found in the coarse inorganic faction of the soil. Minerals are not equally distributed in soils. They are more abundant in young soils than old ones.

Micro Nutrients	Chemical Symbol	Ions Used by Plants
Molybdenum	Mo	MoO_4^{--} (molybdate)
Nickel	Ni	Ni^{++} (nickelous)
Copper	Cu	Cu^{++} (cupric)
Zinc	Zn	Zn^{++} (zinc ion)
Manganese	Mn	Mn^{++} (manganous)
Boron	B	BO_3^{--} (borate), $B_4O_7^{--}$ (perborate)
Iron	Fe	Fe^{++} (ferrous), Fe^{+++} (ferric)
Chlorine	Cl	Cl^- (chloride)

Sources of Nutrients

Macro Elements

Nutrients	Source
Nitrogen (N)	• all leguminous plants • manures – particularly chicken • thistles • nettle • comfrey • dandelion • clover • alfalfa (lucerne) • bracken
Phosphorus (P)	• comfrey • alfalfa (lucerne) • chickweed • wild tobacco • bone meal or fish emulsion • sorrel • garlic • nettle • dandelion
Potassium (K)	• bracken • comfrey • borage • dandelion • nettle • yarrow • fennel • inkweed (phytolacca) • earthworm castings • chamomile • tansy
Calcium (C)	• nettle • kelp • comfrey • chickweed • dandelion • willow • limestone (Calcium carbonate) • dolomite (Calcium magnesium carbonate) • chamomile • meadowsweet • fat hen • horsetail (equisetum)

Continued over page

Magnesium (Mg)	• nettle • kelp • chickweed • broom • dandelion • parsley
Sulphur (S)	• nettle • magnesium sulphate (Epsom salts) • dolomite (Calcium magnesium carbonate) • gypsum (Calcium sulphate) • broom • fennel • cabbage leaves • dandelion

Micro Elements

Iron (Fe)	• chickweed • comfrey • horsetail (Equisetum arvense) • blackberry • dandelion • nettle • fat hen • burdock • watercress • amaranth
Manganese (Mn)	• chickweed • comfrey • nettles • dandelion • peppermint • alfalfa • amaranth
Boron (B)	• chickweed • kelp • petty spurge
Copper (Cu)	• thistles • chickweed • dandelion • fennel • ragwort • yarrow • nettle • spinach • legumes

Continued over page

Zinc (Zn)	• chickweed • nettle • barley grass • seaweed • alfalfa (lucerne)
Molybdenum (Mo)	• garlic • horsetail (equisetum) • poplar leaves • alfalfa (lucerne)
Cobalt (Co)	• nettle • buttercup • legumes • cabbage, cauliflower leaves
Silicon (Si)	• quartz crystals finely ground (silicon dioxide) • horsetail (Equisetum arvense) • chickweed • dandelion • nettles
Chromium (Cr)	• nettles • horsetail (Equisetum arvense) • comfrey
Iodine (I)	• kelp
Selenium (Se)	• nettle • kelp • comfrey
Sodium (Na)	• comfrey • fennel • nettle
Nickel (Ni)	• buckwheat • peas and beans

Source *Plant Nutrition*, written by Sandra Norman, Hunter Valley Organic Growers Magazine

References used:

A Bio-Dynamic Farmer's Handbook, Norrie Pearce, A N Pearce, NewZealand, 1993
Grasp the Nettle, Peter Proctor, Random House New Zealand Ltd, 1997
Nutritional Herbology, A Reference Guide to Herbs, Mark Pedersen, Wendell W Whitman Company, 1998

Macro Elements

Nitrogen (N)
Nitrogen is present in every living cell of plant, occurring in chlorophyll, enzymes, proteins and the genes. Young plants or plants that are actively growing need high quantities of nitrogen. An abundance of nitrogen is particularly evident in leaves, which will be a lush dark green. On the other hand, a deficiency of this element results in yellowing leaves (less chlorophyll) and eventually stunted growth of the plant. It is well to remember that an excess of nitrogen will produce very leafy plants with few flowers and also plants that are soft and therefore vulnerable to attack by pests and diseases.

Phosphorus (P)
Phosphorus for essential for photosynthesis and also regulates cell division, root development and protein formation. If there is a deficiency of this element, growth is stunted and symptoms appear as a general stunting of the older leaves. This is because phosphorus is vital for the making of protein and new cells. Australian soils are generally low in this element so caution needs to be exercised when fertilising plants from the proteaceae family such as banksias, grevilleas, etc.

Potassium (K)
Potassium is essential in all cell metabolic processes of a plant, influencing the uptake of other elements. It is needed for the stems of plants to lengthen and it also promotes thickening of the cell walls, which gives protection to the plant from disease. It is essential for good flower and fruit growth. A deficiency of K will be indicated in the older leaves which go a dull grey-green with the leaf margins going yellow in spots. Stalks are also thin and shortened.

Calcium (C)
One of the key functions of calcium is in maintaining the cell wall structure of plants and it is necessary for the proper functioning of growthing points. Deficiency symptoms show as a slight paling of the leaf margins (youngest leaves) behind the branch tip and die back in the root system (difficult to see!!). In combination with magnesium, calcium helps taking up salt in the soil solution.

Magnesium (Mg)
Magnesium is essential for photosynthesis because every chlorophyll molecule has a magnesium atom at its centre. An indication of a deficiency appears on older leaves with the interveinal areas becoming mottled and turning yellow – the leaf veins remain green. The leaf gradually dies and defoliation occurs.

Sulphur (S)
Sulphur is a constituent of some amino acids and all proteins. Some plants such as cabbage and onions contain sulphur rich oils, which gives that familiar aroma of these vegetables. As with nitrogen, sulphur has to be converted by soil micro-organisms before becoming available to plants and also like nitrogen, it can be leached from soils, particularly in sandy soils. Symptoms of deficiency also show as a general paleness in the leaves and stunted small leaves, but unlike nitrogen deficiency, which affects the older leaves, sulphur deficiencies appear on the youngest leaves first.

Micro Elements

Iron (Fe)
Although iron is not a constituent of chlorophyll, it is essential for chlorophyll formation and to enable plants to use nitrate (nitrogen). There needs to be a constant supply of Fe and a deficiency shows up in the youngest leaves with the interveinal areas becoming pale, then yellow then white or pink, tinged with vines standing out distinctly green. This is known as iron-chlorosis and is most common on alkaline soils.

Manganese (Mn)
Manganese is necessary for photosynthesis and the making of proteins. Nitrogen metabolism is also dependent on manganese availability. A manganese deficiency is very similar to an iron deficiency but is more marked and the leaf veins are a pale green with feathery edges.

Boron (B)
Boron is connected with the uptake and utilisation of calcium in plants. It is necessary for the development of new cells in actively growing parts of a plant – root tips, ends of stems and flower buds. It is worth mentioning that many household detergents contain boron and as there is a very small margin between deficiency and toxicity, grey water should be used cautiously. It is necessary for brassicas and beetroot and also for the fixation of nitrogen by bacteria in the nodules of legumes. A deficiency is not always easy to discern because of its many functions, however some of the symptoms are crinkling of interveinal areas and minor veins, becoming brown and distorted and root tips drying.

Copper (Cu)
Copper is necessary for chlorophyll formation as well as playing a part in many other chemical reactions that occur in plants. It is toxic in high concentrations. A deficiency is indicated by leaves turning blue-green, leaves dying in patches, weak new shoots and shortened stems.

Zinc (Zn)
Zinc is necessary for plant growth rate and development. The hormones that control the lengthening growth of stems and roots and leaf expansion need zinc. Another function is its regulatory role in the uptake of water by plants. A deficiency will vary between plants – some will have mottling of older leaves, younger leaves may be much small then usual and distorted, fruit and flower production severely affected and older leaves sometimes develop purple tints.

Molybdenum (Mo)
All plants have a need for molybdenum to convert nitrates into amino acids and proteins. If there is a deficiency, then nitrate can accumulate in the plant and impede its assimilation – plant growth is restricted. Legumes have a special need for this element, as nitrogen fixation is dependent on it. Only trace amounts are needed.

Other Elements of Importance:

Cobalt (Co)
This is another element that is necessary for the formation of root nodules and the process of nitrogen fixation in legumes. It is not considered necessary for all plants.

Aluminium (Al)
This is an element that is quite common in many clay minerals. If it is in large amounts, it is toxic to most plants. It is thought that it may help plant growth by reducing phosphorus toxicity.

Silicon (Si)
Conventional agriculture recognises silicon as one of the miscellaneous elements, with varying recognition as to its importance. It is considered by some agriculture scientists to affect plant mineral nutrition and to promote growth. It is also considered to help plants reduce the risk of fungal diseases. Practitioners of biodynamics view silicon as begin very important. Peter Proctor in his book "Grasp the Nettle" has this to say about silica:- "The extra light is concentrated on the plants, increasing photosyntheses, strengthening the plant and encouraging the development if fruit and seeds." Biodynamic farmers consider Equisetum arvense a very valuable resource to reduce fungal problems – it is used as a preventative rather then a cure. Once again this is just sensible practice!

There are other elements which are taken up by plants with the three following elements being essential in trace amounts for the health of animals and humans.
Chromium (Cr), Iodine (I), Selenium (Se)

It may appear to be difficult to ensure your soil has ample supply of all these essential nutrients, however soil with good texture and structure with high levels of organic matter and a pH of around 6.0 to 7.0 will ensure these nutrients will be both in supply and available to the plants. Kelp and nettle are both very good sources of a broad range of nutrients promoting strong, healthy plants resistant to pests and diseases. Basalt dust is also high in trace elements. Do not make the mistake of thinking that if a little is good, more is better! Many of these nutrients are only required in trace amounts and balance is the key.

It is essential of course, to be continually replenishing the fertility of the soil – as the plants absorb nutrients then naturally they need to be replaced. Plants grown in rich, well-balanced soil conditions are less likely to be susceptible to attack by pests and diseases. Once again, it's all in the soil!!

Organic fertilisers are by far the best way to look after the soil. The plants are able to take up nutrients from these natural sources (assuming there are no other limiting factors) when they need them and in the quantities required. The importance of recycling all organic matter back into the soil cannot be emphasised enough – as it decomposes the humus that is the final product rich in these essential macro and micro nutrients which are held in the soil in a stable and available form. Compost made with a wide range of materials, including the many sources motioned above, will provide a well balanced source of nutrients.

Source *Plant Nutrition*, written by Sandra Norman, Hunter Valley Organic Growers Magazine

Nutrient Availability

Plants only take up nutrients which occur as simple ions. Not all nutrients are available because they are combined with minerals, organic matter, or other elements in solution to form low solubility compounds.

Requirements for nitrogen fixation are pH between 6.5 and 6.8, soil contains rhyziobium bacteria, molybdenum (Mo) and cobalt (Co) are present.

Nutrient Deficiency Symptoms of Plants

Note: Nutrient deficiencies in plants can be identified through observations of deficiency symptoms or through laboratory testing of plant tissues.

Deficiency Symptom	Nutrient Element
Stunted growth, delayed maturity, light green leaves; lower leaves turn yellow and die.	Example: Nitrogen (N)
Purplish leaves, stems and branches; reduced yields of seeds and fruits, stunted growth.	Phosphorus (P)
Reduced yields; mottled, spotted or curled older leaves; marginal burning of leaves; weak root system, weak stalks.	Potassium (K)
Deformed terminal leaves, reduced root growth. Some plants turn black, dead spots in midrib in some plants. Failure of terminal bud.	Calcium (Ca)
Plants usually chlorotic (interveinal yellowing of older leaves); leaves may droop.	Magnesium (Mg)
Light green leaves, reduced growth, yellowing of leaves. Weak stems. Similar to N deficiency.	Sulfur (S)
Terminal buds die, lateral branches begin to grow, then lateral buds die, branches form rosettes. Leaves thicken, curl, and become brittle.	Boron (B)
Terminal leaf buds die. Chlorotic leaves. Stunted growth. Terminal leaves die.	Copper (Cu)
Plants wilt. Chlorotic leaves. Some leaf necrosis. Bronzing in leaves.	Chlorine (Cl)
Paling or yellowing of leaves, chlorosis between veins at first. Grasses develop alternate rows of yellowing and green stripes in leaves.	Iron (Fe)
Network of green veins on light green background of intervenous tissue. Leaves later become white and abscise.	Manganese (Mn)
Plants may become nitrogen deficient. Pale green, rolled or cupped leaves, with yellow spots. Leaves of crucifers become narrow, cereal glumes do not fill out.	Molybdenum (Mo)
Abnormal roots; mottled bronzed, or rosetted leaves. Intervenous chlorosis.	Zinc (Zn)

Nitrogen Fixation

The nitrogen fixation (N2-fixation) is a process between the legume plant and rhizobia bacteria. Through this process Rhizobia bacteria provide the legume plant with nitrogen in the form of ammonium and the legume plant provides the bacteria with carbohydrates as an energy source.

The rate of N2-fixation by legumes is directly related to legume plant growth rate. Anything that reduces plant growth such as drought, low temperature, limited plant nutrients, or disease will also reduce N2-fixation. Maintaining sufficient leaf area in a legume stand to intercept most of the sunlight is also critical to maintaining a high growth rate to support N2-fixation.

Nitrogen Fixation of Legumes

The following activity will enable you to identify the nitrogen fixing capacity of your soil.

Are the Rhizobia in your legume crop fixing nitrogen?

Different leguminous crops require specific Rhizobium species for the formation of effective nodules and nitrogen fixation. If the correct Rhizobium are absent they can be inoculated into the soil.

Aim: To test you soil for the presence of Rhizobium and to assess their capacity to nodulate a legume.

What you will need;

- 1.5kg of soil taken from the top 0-10cm. This should be collected from several sites across the paddock
- 15 legume seeds (e.g. peas, beans, lupins)
- 10% bleach solution (10ml of household bleach diluted with 100ml of water)
- 3 large yoghurt pots with several drainage holes in the base
- a garden soil sieve
- an old tea strainer

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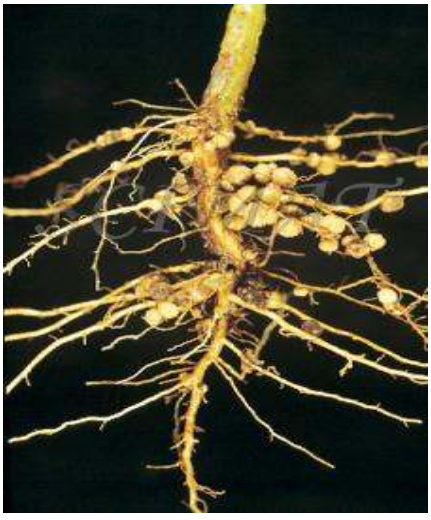
What to do;

- Sieve the soil to remove any large stones and pieces of organic debris.
- Add sufficient water and mix to bring the soil to field capacity. The soil should feel wet when squeezed in the palm of the hand.
- Fill each pot with about 500gm of the moist soil.
- Place the seeds in the tea strainer and dip them in the 5% bleach solution, covering them for a maximum of 30 seconds. Rinse with copious amounts of clean, cold water. The objective of this is to sterilise the seed surface to remove any Rhizobium carried by the seed. Care should be taken when handling bleach.
- Plant 3 – 5 seeds, 2 cm below the surface in each pot, then place in a warm sunny position. The pots should be watered regularly to prevent the soil drying out.
- After a week thin the seedlings to 3 per pot. The plants should be left to grow a further 4 weeks.
- After 5 weeks from sowing, carefully remove the plants from the soil. Remember it is the roots that we need so care should be taken when freeing the roots from the soil.
- Gently wash the soil from the roots and lay on a sheet of white paper.
- Compare the root to the photograph of a noduled root.
- Count the number of nodules on the root. Each plant requires more than 10 nodules to achieve a high level of nitrogen fixation.
- Separate 10 nodules and cut them in half using a clean razor blade or sharp knife. Nodules which are effectively fixing nitrogen will be pink inside; those which are not will be white or green. The more intensive the pink colour, the better the nodules effectiveness in fixing nitrogen.
- Identify any plants which have not fixed nitrogen to determine the site where the soil used for this experiment was sourced from.



Under the microscope. If you have access to a microscope gently squash a nodule on a slide. Rhizobium cells can be seen as 'Y' and 'T' shaped bacteriod cells.

Gupta, V., Neate, S., Leonard, E., *Life in the Soil*, p10, Co-operative Research Centre for Soil and Land Management, South Australia

BD507 to Enhance Phosphate Availability

Use of Cow Pat Pit and liquid manures as mediums for distributing the Valerian Preparation (BD507) to enhance phosphate availability to plants through the action of phosphatase enzymes. A paper produce by FiBL (Fliesbach *et al.*, 2000) on nutrient dynamics on biodynamic systems concluded:

> The results of this research support the hypothesis that the biodynamic system invokes higher efficiency of the soil microbial community with respect to substrate use for growth. In other words, they make better use of the soil's natural resources. The soil system ("Black Box") functioned more efficiently under organic farming systems. In Biological terms that also means that the organ (soil life) functions well and therefore the body (soil) is able to perform. A healthy body can be maintained only if its organs perform their task.

Waldon *et al.*, (1998) also compared the performance of two very similar soil ecosystems under organic and conventional management. They concluded:

> The lower N and P contents of the organic site, considered with their healthy plants and high production, call for re-evaluation of soil test methods and standards for organic farming systems. The organic farming systems may use mineral nutrients in a more efficient manner and allow lower inputs.

This can partially be explained by the use of organic fertilisers as opposed to inorganic fertilisers. Moritsuka *et al.*, (2001) studied the effects of organic and inorganic fertiliser on the nutrient dynamics in the rhizosphere, and concluded that the contribution of the net supply of N, P and K through the replenishment from the solid phase was higher for the organic fertiliser treatment than for the inorganic fertiliser treatment. In short, inorganic fertilisers reduce the efficient use of the soil system's mineral resources.

In the light of these results, the concern of Condron *et al.*, (2000) about continuous phosphate availability under organic soil management might not be warranted. Phosphate availability is largely determined by mineralisation (by phosphatase enzymes) due to microbial and plant activities (Speir & Ross, 1978). Phosphorus mineralisation rates are correlated to nitrogen mineralisation rates, microbial activity and humus. It is decreased by high phosphate concentrations. Mineralisation rates are also higher in the rhizosphere. Oberson *et al.*, (1993) reported that the soil microbial biomass and the activity of the enzyme acid phosphatase were higher under the organic soil management plot in their long-term field trial. These results were attributed to both the higher quantity of organic carbon and organic phosphorus (organic matter) applied in these systems and also to the absence of or severe reduction in chemical plant protection. A further conclusion drawn was that phosphate could not be the factor limiting crop yield under organic management.

The ability of phosphorus to leave the soil solid phase was significantly higher under the biodynamic treatment than under all other treatments. This was explained by the higher calcium and organic matter contents in this system. Other important factors in increasing phosphorus uptake are the presence of mycorrhizal associations and earthworms, which have been extensively reviewed (e.g. Quaroles, 1999; Singh & Aneja, 1999; Lee, 1085; Pankhurst *et al.*, 1994).

The soil system with its components of soil organic matter, soil life community structure and nutrient dynamics plays an essential part in the global water, carbon, nitrogen, phosphorus and sulphur cycles. Soil organic matter and biomass are a major sink or pool for carbon, nitrogen, phosphorus and sulphur. The turnover, cycling rate and availability are under the influence of soil organisms.

*Review of New Zealand and International Organic Land Management Researc*h, 2002, pgs 33, 34.

Worm Castings

The use of worm castings can bring many benefits and improve the humus content of the soil. They are a good supplement to the biodynamic system but should not replace biodynamic compost. Worm castings can be incorporated directly into the soil or made into a liquid manure.

Liquid Vermiculture
To make liquid vermiculture put 20kg of vermiculture into a 200 litre drum of fresh water, add the biodynamic preparations and leave for three weeks. Stir daily.

Spray at a rate of 10 litres of concentrate liquid, with enough water to spray per acre (equivalent of one kg of castings per acre).

Earthworms Release Potassium into the Soil

By Gareth Bodle

Earthworms can release potassium from non-available forms in the mineral part of the soil. This is one of the conclusions in a paper published by Massey University (New Zealand) soil scientists in 1995. Entitled "Changes in potassium availability and other soil properties due to ingestion by earthworms" it is the most recent of three studies on earthworms.

It is well known that earthworms increase the availability of nitrogen and phosphorus in the top ten centimetres of the soil, but up until now scientists had only 'suspected' that this was also true for potassium. Dr MacGregor and his team have now identified the process in soil science terms, and he described their work as a 'world first'.

Trials show that the digestive processes of the earthworm actually release potassium from the mineral part of the soil. "If earthworms are encouraged to do their thing, they could produce up to 50% of what is delivered by a 'normal 15% potassic super', with the rest of the pasture requirements coming from normal soil chemistry," Dr MacGregor said. However some volcanic and sandy soils may not be able to achieve this.

Published *Harvests,* Autumn, 1995, Journal of BDFGA in NZ

Worms that Turn

By Gareth Bodle

Earthworms can release potassium from non-available forms in the mineral part of the soil. This is one of the conclusions in a paper published by Massey University soil scientists last year. Entitled "Changes in potassium availability and other soil properties due to ingestion by earthworms" it is the most recent of three studies on earthworms. The language of the paper is the terse, technical style of the world of science, but Dr Neil MacGregor, one of the authors, points out that they have produced important evidence, particularly for organic and Bio-Dynamic farmers.

Continued over page

It is well known that earthworms increase the availability of nitrogen and phosphorus in the top ten centimetres of the soil, but up until now scientists had only 'suspected' that this was also true for potassium. Dr MacGregor and his team have now identified the process in soil science terms, and he described their work as a 'world first.' He also points out that whilst the bio-dynamic farmer can find sources of phosphorus (RPR) and nitrogen (cow manure, green manure crops etc.) he appears to have less control over potassium. Thus, the scientific way of looking at things now offers some further information about the way potassium becomes available on bio-dynamic farms. This adds another factor to our picture of the beneficial and enhancing effects of the biodynamic preparations.

The trials show that the digestive processes of the earthworm actually release potassium from the mineral part of the soil. "If earthworms are encouraged to do their thing, they could produce up to 50% of what is delivered by a 'normal 15% potassic super', with the rest of the pasture requirements coming from normal soil chemistry", Dr MacGregor said. However, some volcanic and sandy soils may not be able to achieve this.

And why have New Zealand and Australian farmers not been told that what Bio-Dynamic and organic farmers rely on for their potassium source has been described scientifically? Well, Dr MacGregor has had well over fifty enquiries from Asia, Africa, North and South America, The Middle East and Europe, but none from Australia or New Zealand. "Our soil scientists have their eyes closed", he said.

Harvests, Autumn 1995, Journal of BDFGA in NZ

Remineralisation of Soils

It is advisable to remineralise productive land every 10 years. Good sources of minerals include liquid seaweed and paramagnetic rock dusts.

Basalt is a paramagnetic rock dust that can be applied to any land type. Basalt can be applied directly onto the soil or used in Manure Concentrate or as an ingredient in compost. It is an excellent soil remineraliser as it contains a diverse mixture of minerals and is well suited to renewing exhausted land.

The Role of Rock Dusts in Sustainable Agriculture

By Graeme Roberts

The finer the rock powder or dust the more readily can soil micro-organisms transform the rock dust from an insoluble to a soluble state. Attaching themselves to the surface area of the fine rock dust, the microbes consume the minerals in the rock and turn them into a soluble form. This helps build up the humic content of the soil that helps to retain moisture while allowing plants to select the specific elements they need.

The use of rock dusts in composting is extremely beneficial as there is a symbiotic relationship between the two. The compost provides the right medium for a micro-organism population explosion promoted by the dust and the dust helps create more organic matter while helping to hold it in place, improving aeration and structure. (It is suggested that adding up to 10kg of rock dust per cubic metre of compost pile will add to the value of the compost).

Continued over page

This knowledge leads us back to Steiner's awareness of the great benefits of rock dusts, in particular the three distinct types – silica, clay and lime – each with their own cosmic aspects and their effects on the soil and crops and to continuous composting.

There are clear links also to Maria Thun's Barrel Compost, or what we call Cow Pat Pit manure concentrate, whereby portions of finely ground basalt rock powder and finely ground eggshells are mixed thoroughly into cow manure, placed in a pit and enhanced with the compost preparations. The value of analysing the make-up of the different sources of rock dust in not only to be aware of the elements available from crushing the particular rock but also to know the measure of the paramagnetic forces within the rock sample.

Paramagnetism and diamagnetism are subtle low-level forms of energy that work in harmony with nature to harness solar and cosmic forces. They generate two opposite energy fields which are mutually dependent and provide a sustained harmonic energy field that promotes the growth of healthy plants.

Dr Philip Callahan, the lead researcher in this field, has developed a meter for measuring these low level forces. The meter measure for paramagnetism is the speed that a material will move towards a magnet of known intensity; diamagnetism is a measure of how fast a material is repelled from a magnet of known intensity. The force is expressed as centimetres per gram per second multiplied by 10-6.

Dr Callahan is probably best known for his discovery that plants emit infrared radiation that magnifies scent molecules. Insects detect the source of these molecules with their antennae. Healthy plants emit a different signal to unhealthy plants and insects are more attracted to the nutritionally deficient plant and attack them. Dr. Callahans' experience in radio technology and low-level energy fields allowed him to draw comparisons between an insect's antennae system and radio (antennae, oscillators, frequency, electromagnetism, etc). He applied this knowledge to his observations that plant growth around ancient sacred sites involving rocks was better than other areas and his further research revealed that these rocks were highly paramagnetic.

Dr Callahan's description is, "Paramagnetism is the ability of a substance to collect, or resonate to, the magnetic fields of the cosmos. It is not magnetism". He discovered that unlike the antennae of insects, which respond to subtle energies, rocks and rock powders use crystals to collect subtle cosmic energies and transform them into beneficial uses for soil micro-organisms and plants. He likens rocks to a receiver and plant roots as wave-guides like antennae.

His major findings are that compost, micro-organisms and paramagnetism are the major ingredients for sustainable agriculture and that calcium balance is needed to ensure the best response from paramagnetic rock dusts. He also states that the paramagnetic influence does not work with dead, chemically farmed soil but requires a minimum level of organic matter. He suggests that paramagnetism is not a substitute for nutrition but provides different and extra benefits.

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Boral's extensive experiments and plant trials with rock dusts have demonstrated a number of beneficial characteristics. Rock dust with a high paramagnetic intensity produces significantly increased plant growth and overall improved plant health. Their testing of rock dusts around Australia has found many non-basaltic rocks with very high paramagnetism levels but little nutritional value in the form of extensive mineral and trace element content.

An extensive range of minerals will enable a microbial population to be increased and sustained. The microbial population build up is enhanced by very fine particle size (less than 75 microns) but it is the large particles that provide the greatest paramagnetic effect. For ease of application and to gain an overall benefit Boral and Dr Callahan advocate a combination of basalt rock powder particles ranging from 4 millimetres down to very fine powder. Oxygen, which has a reading of about 4000 c/g/s, is one of the most paramagnetic things after paramagnetic rocks and hence the aeration of soils brings an additional benefit.

Organic matter and water have a diamagnetic charge and most rocks have a paramagnetic charge. Individual minerals within a rock will be either paramagnetic or diamagnetic and the pH of many rock dusts can help increase soil pH.

Boral trials compared the effects of lime, dolomite and basalt rock dust on very acidic soil. They found that within 24 hours the pH in pots treated with lime shifted from a pH of 4 to a pH of 7. This is an extremely large increase in the ion count over such a short period and would have caused a very stressful impact on both microbes and plants so treated. Those pots treated with the basalt rock dust hardly showed a change after the first 24 hours but over a period of 87 days the pH in these pots had gradually risen to the point where the pH was the same as for the lime treated pots and this same increase had been achieved without undue stress on the plants and micro-organisms.

Boral trials have shown the value of small quantities of lime in the form of "Sweetpit" (selected lime and selected sugars) combined with basalt rock dust in the right soil conditions. Their recommendations are to apply rock dust at 10 tonnes a hectare and the Sweetpit product at 300 kilograms a hectare. The sugars are a food source for soil micro-organisms and help increase the activity of these organisms.

A final point to remember is that the paramagnetic forces can and will erode over time. Normal farming techniques, rain (and irrigation) all speed up the erosion of these forces.

Incorporating homeopathic lime applications plus basalt rock powders into our soils as a starting point to help remineralise them along with the biodynamic applications of 500, 501, cowpat pit and composting will all contribute to bringing our soils to a healthy, balanced position.

Reference: *Elemental,* No. 61, Journal of Bio-Dynamics Tasmania, 2001

Qualitative Testing in Agriculture

By Peter Wucherer

In recent years agricultural practice has undergone rapid, intensive changes. The mass production of food in monocultures, the use of earthless growing techniques such as hydroponics, unnatural animal husbandry and food designed with gene technology give rise to concerns about the quality of the substances we consume. A steep increase in demand for produce grown in an ecologically sustainable manner is a mirror of those concerns.

Biodynamic agriculture works with and incorporates the biological relationships of the minerals, plants and animals creating wholesome and nutritious food and products containing vital energies, or life forces, which strengthen the whole human being. Farmers go beyond the limitation of the material dimensions of their farm, and work from an understanding of a living totality which needs to be nurtured and supported. Consequently, Biodynamic produce contains a high level of minerals which show high nutritional value, good taste, improved shelf life and, most importantly, vitality for the consumer.

Scientific ways to determine the amount of substances contained in various foods give us means to define the exact amount and percentage of substances such as proteins, fats, carbohydrates, trace elements, vitamins and even the tiniest traces of chemical residues. This 'balance sheet of substances' is the result of a measurable composition of nutrient levels, which, according to experts, relate to the 'daily needs' of nutritional requirements.

Analyses based on material aspects cannot consider the integral organising activities, which are inherent in every living being. Such activities are not a measurable part of contemporary nutritional assessments based on reductionist science. Quality Research {of life giving forces} acknowledges that every substance is created by formative forces or energies which maintain its physical existence. These forces form living crystals which are unique to every vital structure on earth. In a balanced metabolism these are continuously released and used to create new form and substance, moulding the composition of life through ongoing creation and transformation of form. A disturbance or weakening of this process results in disease.

In order to feed the living crystals and sustain their dynamic activity, our foods need to contain dynamic living formative and crystallization forces. In 1924, Rudolf Steiner gave indications on how to assess the *quality of the living* based on spiritual sciences. Following indications given by Rudolf Steiner in 1924, Pfeiffer, Kolisko, Selawry, Hauschka, Feyfe and others pioneered the assessment and differentiation of the *vital quality* of various agricultural products. During my recent studies in Germany at the 'Laboratory Dr. Balzer' I gained first insights into two methods of *Vital Quality Research*: The Rising Picture ('Steigbild') acc. to Wala & Sensitive Crystallization acc. to Pfeiffer.

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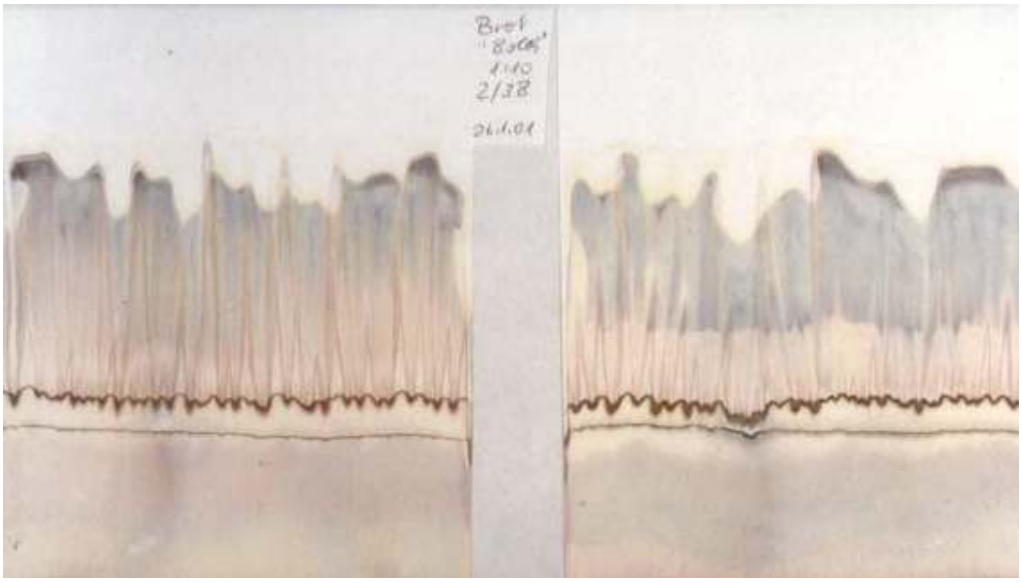
Methodology of Vital Quality Research

The Rising Picture ('Steigbild') (acc. to Wala)
A biological substance, such as an apple, is brought into fluid form, juice, and mixed with water. Once the optimum concentration is reached, the fluid is placed into specially designed glass moulds fitted with a cylinder of chromatographic paper. The fluid slowly rises upwards. After a rising and drying time of 2 hours, a silver nitrate solution is added. The process is repeated for 2.5 hours. Finally a third repeat is made with an iron sulphate solution for 1-2 hours. The emerging picture shows the *Living Dynamics* in the watery *Substance*. The result allows reactions, such as reductivity, colloidal activity, water content and rotting processes to be seen and evaluated. For each substance a series of different concentrations can be made to determine the optimum concentration for comparative studies. Comparisons are made from identical concentrations. Each picture must fulfill the scientific criteria of objectivity and reproducibility.



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Sensitive Crystallization (acc. to Pfeiffer)
The fluid of a biological substance is mixed with water and a copper chloride solution. This mixture is placed on a glass plate and put into a vibration free chamber, where it is kept at a stable temperature and humidity for a period of about 24 hours. The solution gradually dries and produces crystalline forms, which are unique to the biological substance tested. Accurate temperature and humidity control are essential for this crystallization process to occur. As with 'Steigbild', the result needs to be specific and reproducible.

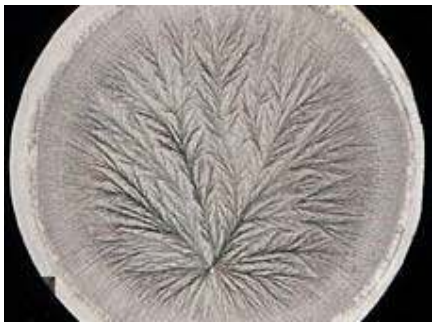
Crystallization pictures show *the Living Dynamics in the Form* and provide an analytical reference and evidence of the formative and crystallization forces inherent in a particular substance. Depending on the quality of the produce being tested one can observe pictures, which show singular or multiple centers, fine or coarse structures and needle type branches, which may be rigid or dynamic in character.

As described above, different criteria of evaluation are applied to each of the two research methods. In the 'Steigbild' one evaluates the *Living dynamics in the Substance.* The produce is examined by drawing upon the analytical-chemical properties of the substance, based on the research question: What are the reactions of the substances in this picture?

In Sensitive Crystallization one tries to observe and evaluate the nature of the *Living Dynamics in the Form* of the tested produce. It is an investigation into the formative and crystallization forces, based on the research question: How can formative forces be made visible?

Both methods exist in their own right and cannot be replaced by the other. They are supplementary and, used in conjunction, provide a basis for qualitative comparisons.

Together, both Steigbild and Crystallization are expressions of the magical interweaving of substances and forces. The confrontation with the inner dynamics of these forms, as demonstrated in image enhancing research methods may become an encounter with nature in a deeper sense, a profound experience, which may penetrate the soul like a work of art.



Newsleaf, Journal of BDAA (Australia), No. 51, 2002

Extra resources:
For information on qualitative methods for testing produce contact: Dr Ursula Balzer-Graf, Switzerland

Chromatography

The Method

Chromatography is a relatively simple qualitative analysis method for evaluating any organic substance through reading the reproducible patterns and colours created on a photo receptive filter paper disc. Whatman No. 1 and No. 4 filter paper is infused with a 0.5% silver nitrate ($AgNO_3$) solution to make the filter paper photo-reactive. This prepares the Chromatography paper for the second stage of the process.

Organic substances to be tested are mixed with a solvent and this solution is then infused through treated Chromatography paper. The Chromatography paper is exposed to light and a reproducible picture is formed.

For analysis of soils and composts, a sample of the soil/compost is mixed with a 1% sodium hydroxide (NaOH) solution in a 1:10 ratio (eg 5 grams soil in 50ml NaOH solution).

The method utilizes the properties of filter paper to separate fractions in a solution by capillary action.

Making the filter paper photo-reactive

About 5ml of 0.5% silver nitrate solution is placed in a small Petri dish and the circular filter paper (which is larger in diameter than the Petri dish) is placed on top of the dish. A wick made from the same filter paper (a square 2cm by 2cm is rolled into a tight cylinder) is pushed through a prepared hole in the centre of the circular filter paper to touch the bottom of the Petri dish and hence the solution. The silver nitrate solution will move up through the wick and across the filter paper through capillary action. When the solution reaches a point about 4cm out from the centre of the paper (marked with a pencil) the filter paper is lifted from the Petri dish, the wick is removed and the paper is allowed to dry.

Testing Procedure

5ml of the previously prepared organic solution is placed in a clean Petri dish. A new wick is made and inserted through the hole in the prepared Chromatography paper and pushed down to make contact with the test solution.

The organic extract solution will move up through the wick and across the filter paper through capillary action.

When the solution reaches a mark 7cm from the centre of the filter paper the circular paper is lifted from the Petri dish, the wick removed and the paper is placed on top of a Petri dish to dry.

The dish is placed in diffuse light of a fluorescent light and allowed to develop colour and intensity. This takes about 20 to 40 minutes.

Dried chromatography pictures are stored in a folder away from sunlight and separated by sheets of dry paper.

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Evaluation
A trained operator can read this picture to determine different qualities in the organic substance analysed.

It takes quite a while to become competent in interpreting chromatograms and it is best to start with well defined substances with strong biodynamic influences (eg BD compost or Horn Manure 500) to build a set of standard chromatograms to use when comparing other substances.

Pfeiffer provides some key points to use when reading chromatograms:

- The number, width and colour of the different zones as how regular or irregular the formation and shading.
- Generally three main zones – outer, middle and inner.
- The outer and middle zones are mainly influenced by organic material.
- The inner zone indicates the presence or lack of mineralisation.
- Ring formation at the edge of the outer zone and between the middle and outer zone.
- Light to medium brown colours, evenly distributed, points to good colloidal humus formation; violet radiations points to increasing mineralization and reduced organic substance.
- Radiating lines and the number, colour and shape of spine-like formations.
- The more movement and strength of the rays and how far out they penetrate gives an understanding, or impression, of the liveliness of the test substance.
- The liveliness of the middle zone correlates to the life forces of the test substance.

For detailed evaluation see "Chromatography Applied to Qualitative Testing", Pfeiffer, 1984.

Article sourced from *Elementals,* Journal of Bio-Dynamics Tasmania, An Introduction to Chromatography, Graeme Roberts, Issue 91, 2008, pp30-36.

Brix Testing

Professor A. F. W. Brix was a 19th Century German chemist (b. 1798, d. 1890). He was the first to measure the density of plant juices by floating a hydrometer in them. The winemakers of Europe were concerned that they could not predict which of various grape juices would make the best wine. Being able to judge quality ahead of actual bottling was of immense importance in an industry where a bottle of the best wine might sell for hundreds of times more than a bottle of everyday wine. Professor Brix was greeted as a great hero when he emerged from his laboratory to claim his most generous prize. He was also honoured by having the measuring process named after him.

- BRIX is a measure of the precent solids (TSS) in a given weight of plant juice – nothing more –nothing less.
- BRIX is often expressed another way: Brix equals the percentage of sucrose... Sucrose can vary widely. For, indeed, the BRIX is actually a summation of the pounds of sucrose, fructose, vitamins, minerals, amino acids, proteins, hormones, and other plant solids in one hundred pounds of any particular juice.
- BRIX varies directly with plant QUALITY. For instance, a poor, sour tasting grape from worn out land can test 8 or less BRIX. On the other hand, a full flavoured, delicious grape, grown or rich, fertile soil can test 24 or better BRIX.

Remember that sugar is only one of the components of brix. Also remember that many other substances can falsely indicate "brix" readings (although those readings are valid in their own right). Try rubbing alcohol, whiskey, vinegar or wine. Interestingly, cooking oil, molasses, syrup, and other thick liquids require a refractometer calibrated to read 30 – 90 brix. Honey is checked with a refractometer calibrated to measure the water within it instead of the solids in the water.

Sugar Refractometers

By Martin Warren

An extremely useful tool, not found in the garden shed or in the farmers artillery is the 'Sugar Refractometer'. This small, hand held device is extraordinarily accurate and measures the specific gravity of the sugar content present in virtually any plant, whether that is a vine, cabbage or wheat crop. According to an ACRES, USA article, poor readings indicating low sugar levels, will no doubt mean an insect problem. Once readings hit above average or at the good end of the scale, the danger of insect and fungal attack is passed.

Insects cannot endure a plant with the right sugar and mineral levels. But of course, don't take the readings at the time of harvest – its too late then. We all know it is a healthy soil that feeds the plant and you must check progress as the plant is growing, ensuring that the sugar levels are rising as development occurs. If not, as measured against the scale of previous performance, give more attention to raising soil fertility and humus via organic matter. Thus it is essential to keep a register of progressive readings for your various plants during their growing life so that any preventative action can be taken whist it will still be effective.

Unfortunately, there are many excellent crops that conventional farmers shower with toxic chemicals when spraying isn't really necessary. This could have been indicated by use of a Sugar Refractometer.

The Sugar Refractometer needs no special skill to use, is amazingly accurate and will certainly alert growers to potential insect problems whist there is still time for preventative measures. A great investment.

Nutrient Testing

"Conventional soil mineral analysis is helpful in indicating whether there are major deficiencies and imbalances in soil minerals, but generally only shows what elements are present in inorganic from in the depth of soil sampled at the particular time at which the soil test was taken."

Review of New Zealand and International Organic Land Management Research, 2002

Soil Mineral Analysis

"Most people have strong trust in any scientific work. Therefore, when it comes to soil fertility, farmers might also think of getting their soil analysed in a laboratory. Though chemical soil testing may yield valuable information to specific questions, farmers should not expect too much of it.

"For example there are some inherent problems related to analysing nutrient contents: For the plant, the total content of a certain nutrient in a sample is not always relevant, as the nutrient may be absorbed to minerals so strong that it is not available to the plant roots (e.g. Phosphorus). Therefore, some tests treat the sample with solvents in order to simulate the fraction of the nutrient availability to plants. This might be a realistic simulation for conventional farming. In organically managed soils, however, the higher activity of soil organisms can result in a better availability of the nutrient, thus the result of the test is not fully appropriate. The content of other nutrients such as nitrogen is extremely fluctuating within a few days, so that it highly depends in the point of time when the sample is taken. Still, chemical soil analysis can be useful in some cases, e.g. to analyse the levels of acidity of the soil (pH) or to detect deficiency of nutrients such as Potassium (K) or Zinc (Zn).

"Organic farmers might be especially interested in knowing and monitoring the content of soil organic matter.

"Chemical soil analysis on pesticide residues is highly complicated as one must know which pesticide to look for, and they are very costly. Physical testing, e.g. related to water retention capacity or soil structure can yield interesting information, but samples must be taken very carefully. Biological analysis, e.g. of the acidity of soil organisms, must be done in specially equipped laboratories and is rather costly. Altogether the use of soil analysis on the farm level is limited due to the scientific methods, the availability of suitable laboratories, and the costs involved. If soil tests are used, make sure that the relevant aspects are investigated and the results of the test are critically discussed."

IFOAM Training Manual for Organic Agriculture in the Tropics, 2003,
Complied by FiBL, ISBN 3-934055-25-7

Fluctuating Nutrient Cycles

"The Australian Soil and Plant Testing Council recently conducted a survey on Australian soil testing laboratories, sending identical standardised soil samples to 18 laboratories across the country. The results of tests for nitrogen, phosphorus and potassium concentration varied so widely that the usefulness of soil tests in general must be seriously questioned. Phosphorus levels on one sample varied between 15.3mg/kg and 56mg/kg, while for another the range was 0-62mg/kg! One sample tested for potassium levels varied between 70 and 600ppm.

"This raises some interesting questions – are the standard testing methods themselves reliable, are laboratory standards of practice acceptable, or in fact is there some process at work here that we do not fully understand. Are living processes, such a microbial activity, in the 'identical' soil samples, resulting in variations?"

Source, *The Weekly Times*, December 17th, 2003, p1. Article by Peter Hunt