Lesson 3

The Universal Law of

Alignment and Balance

Lesson Summary

•In Lesson 3 we look at the importance of building and maintaining a balanced soil. There are three aspects to be addressed in relation to improving soil fertility. These are:
(a) **levels** and **balance** of minerals
(b) **variety** and **number** of soil micro-organisms, worms and insects
(c) **amount** of organic matter.

•The role of the major minerals in soils is outlined.
•As a consequence of this lesson you will understand the huge damage that is being caused by overuse of agricultural chemicals and agricultural poisons.

Review of Lesson 2

In Lesson 2 we highlighted the importance of composting and humus, preparation for tree planting and care of trees. We also introduced a radical idea that pests and diseases only cause problems when the soil is infertile and out of balance. Their job is to get rid of unhealthy plants to stop them reproducing.

Task 1
Before starting Lesson 3, take time to review what you have achieved so far.

My achievements so far include:

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My next tasks include:

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Complete the following statements.

1. The idea I found most interesting in Lesson 2 was:

2. The information from Lesson 2 I found most useful was:

3. Using a scale of 1 - 5 where 1 equals closely aligned to how you think and believe and 5 equals right out of your comfort zone, rank the following ideas in terms of how closely aligned they are to what you believe.

a) What we say has an energy frequency. 1 2 3 4 5
b) Words and thoughts influence our environment. 1 2 3 4 5
c) Insects are nature's garbage disposal agents. 1 2 3 4 5
d) Highly mineralised food is poison to insects. 1 2 3 4 5
e) Plants give out infrared emissions. 1 2 3 4 5

4. What will you do differently, as a consequence of reading the information contained in Lesson 2?

5. Imagine you have your own commercial composting business called "Rotten Stuff". You need to create a sales brochure to convince people that they absolutely need to have lots of "rotten stuff". What will you tell them in your brochure?

The Importance of Maintaining Earth's Balance

Nature provides us with a brilliant demonstration of what happens when things get out of balance.

Believing we can play God, we have sought to control natural systems and "improve" natural environments to satisfy our greed. Global warming, soil salting, food shortage, desertification, water shortage, destruction of fisheries and deforestation are all consequences of our need to control, take and use without thought for the consequences.

These problems are all signs of imbalance. They are also an indication that Earth is under huge strain. We have caused these problems. Vast areas of Earth have been turned into desert and wasteland by inappropriate farming methods, mining and clearing. The great majority of valuable fisheries have already either collapsed or are in steep decline.

Earth has been scarred by man's greed and need for control. We have sought to change Earth's shape by reclamation and levelling of land. We have changed the Earth's draining systems by damming and redirecting rivers. We have changed landscapes by removing huge mountains and digging massive holes to extract mineral ores. We have changed the Earth's vegetation by cutting down trees indiscriminately, and importing exotic plants to replace those that grow naturally. These changes have been carried out with the aim of acquiring wealth. In seeking wealth unwisely, we have destroyed the means through which that wealth is available to us.

There is nothing of value to Man in areas of salt encrusted hardpans, dead trees and dry rivers: the consequence of our intervention. We are forced to leave these areas of total destruction and desolation. Left alone, systems return to a point of equilibrium, which shows us the power of natural systems. Soil, if it is left alone, actually returns to balance. This is nature's way. The problem is that it takes a long time: a much longer time than it took to upset the balance.

When we interfere with natural systems, we create problems for ourselves. It is time for us to realise that Earth is not something that can be abused thoughtlessly forever without us suffering the consequences.

Human life, which does not take this into account and acts as if it is disassociated from Earth's natural systems, is an example of power without responsibility. People who act this way have forgotten that life on Earth is the means to achieve balance between the spiritual and the material worlds. Our ultimate goal is to create "heaven on Earth" as a demonstration of who we are and as a solid reminder of our role as co-creators with Universe. The ultimate outcome of separation from Earth is annihilation. Unless we validate Earth's role as a life support mechanism, we place it in limbo, apparently separate from us and without a role to play.

Interestingly, while we remain locked up in high-rise offices and apartments and live in artificial environments of concrete, brick and steel, the problems we have created seem remote. Whilst we may intellectually understand that they exist, they do not touch us emotionally. When we get back in touch with the land, we also get back in touch with our feelings.

It is likely that climate extremes will become the norm. Destructive hurricanes where no hurricanes have ever occurred before, extreme variations in temperature, hail and tempests of increasing violence and flooding are now an everyday experience. Mt Tamborine climate records have been kept for over 100 years. In 2007 we experienced the coldest May on record, the wettest June and the driest July.

In nature, plants and soil are in balance. Earth in its pure state is prolific. It is capable of producing far more than is required by the population. Poisoning the soil and removing trees gradually decreases Earth's ability to produce. Food may look good yet not contain the nutrition essential for man's well being when it is grown in soil that lacks the nutrients necessary to maintain balance.

It is possible to create a totally artificial, chemical based environment in which to grow vegetables. This is what large-scale farmers do to ensure they get high yields. Eventually this form of agriculture gets to the point where soil is simply the medium in which plants stand. The plant food source is artificial and plants are "force fed". They have no control over what they take in. Everything is provided in the most easily absorbed form possible. Just as a non-challenging bland environment creates uninspiring bland people, food also becomes bland and tasteless. Soil organisms, which work in balance to produce fertile soil and healthy plants, cannot be supported in such an environment.

When I first arrived at "Castelen" I started a large vegetable garden. The first year I produced bug eaten cauliflowers and lots of weeds. Huge swarms of white butterflies visited daily. I was particularly interested in the cauliflowers. I observed that they became grub infested partly because the leaves weren't big enough to cover the developing heads. Nature is very clever, I thought: healthy cauliflowers don't get damaged because they are enclosed in a tight bundle of leaves right up until they are ready to be picked.

I could have used chemical poisons to kill the white butterflies so that they wouldn't lay eggs, which, when left to grow, become caterpillars. I chose not to.

I knew that the soil only gains balance and its ability to support nutritious food when it remains unpolluted, so I had no real choice. I had to learn what to do to get the soil fertile and in balance. I knew also that when we poison the soil with chemicals and insecticides, mankind ultimately is also affected. What we put in the soil ultimately ends up within us. Poison the soil and we poison the water upon which everything depends. Poison in the soil ultimately ends up in the rivers and oceans and destroys their balance, causing depletion of the apparently never-ending abundance of fish. If we continue poisoning the soil, water and air we will suffer the consequences. Eventually we will learn from our mistakes, because, deep down, we know that we have chosen to do this to learn some very important lessons.

Through my simple observations of my cauliflowers, I realised that there are ways to feed everyone without poisons and without the need to employ vast armies of machinery.

Creating a Balanced Soil

Australian soils are very old and generally poor in mineral content because of their age.

What we are proposing is a way you can bring your soil back into balance using the resources that are available around you.

Your first goal is to re-balance the mineral content of your soil. The second step is to replenish the huge variety of micro-organisms, which give the soil its life. To do this, you have to provide food for those micro-organisms in the form of organic matter. Building organic matter within the soil is the third step of a 3-step process.

There has been a lot of research done in terms of what constitutes a soil that has its mineral content in balance. Dr. William A Albrecht, medical doctor and researcher, worked out that there is an optimum fertility load for soils in the same way that there is a health-giving nutritional level for human beings.

Soil is made up of organic matter, water, oxygen, carbon dioxide, micro-organisms, worms, fungi and clay, sand, humus particles and a range of cations which are attached to the clay and humus particles in the soil.

Dr Albrecht found that the best crop production comes from a soil in which the mineral balance is 65% calcium, 15% magnesium, 2-5% potassium and 5% of all other base elements. Hydrogen, a non-nutrient element accounts for the other 10%. Hydrogen determines the pH, which is the measure of the concentration of the acidic non-nutrient hydrogen element stored on the clay colloids in soil. A pH of more than 7 indicates there is no hydrogen stored on the clay. It has been replaced by more plant-useful elements.
The ideal pH level for plants, animals and humans is 6.3 - 6.8. If the pH level is maintained between 6.3 – 6.8, plants, animals and humans will be healthy. Any deviation from this level indicates an imbalance and likelihood of disease because different chemical reactions occur in humans, plants, animals and micro-organisms depending on the pH level.

pH levels become self-adjusting when calcium, magnesium, potassium and sodium are in proper balance.

The "ideal" soil takes time to achieve. Whilst working to achieve this "ideal" it is important to maintain balance between the elements. **Any increase in mineral content of one element must be balanced by an increase in all elements, in the right proportion.** Improved results will be gained by bringing the soil into balance even if the balance is at a lower level of fertility than what is optimal. Gradual improvements can be paid for by increased productivity, which comes from bringing the soil into balance.

Your soil is only as fertile as the level of the most deficient major element. This means that if your soil has only 50% of the calcium it should have to be in balance with the other major elements, it will be only 50% as productive as it could be.

Albrecht identified many key ratios between key elements that need to be monitored.

The most important of these is the calcium/magnesium ratio, which is 7:1 in a clay soil and may be as low as 4:1 in a sandy soil. A low calcium/magnesium ratio restricts levels of available oxygen because the soil structure "closes up". Another

important ratio is phosphorus and potassium which need to be 1:1. A healthy balanced soil also requires Vitamin D, boron, manganese and zinc for optimum absorption by plants.

In plants, when the potassium/sodium balance is inverted i.e. where there is more sodium than potassium, plants will take in sodium rather than potassium.

About Elements

There are 92 elements.

Elements have three functions:

a) They provide the structural material for roots, trunks, stems, branches and connective tissue,
b) They allow electrical impulses to be transmitted,
c) They act as catalysts involved in numerous physiological processes such as energy storage, synthesis of complexes that protect plants from disease and insects.

Plants and animals require the same elements for similar reasons.

Carbon, hydrogen, oxygen and nitrogen are freely available provided a correct balance of all the other elements is maintained.

Carbon is released through the decay of organic matter. Carbon dioxide is freely available in the air but **most of the carbon dioxide used by plants comes from the activities of aerobic soil organisms** because there is insufficient carbon dioxide in the air.

Stomata are the cells found on the underside of leaves. They open and close to allow passage of water and gases into and out of the plant. Since most of the carbon absorbed by the plant comes from the activities of the micro-organisms in the soil, the stomata are perfectly placed to take in the carbon dioxide that aerobic organisms give off.

Key Ratios in Terms of Soil Balance

Calcium / magnesium	4:1 - 7:1
Phosphorous / zinc	10:1
Potassium/sodium	5:1
iron/manganese	1:1
Magnesium/potassium	1:1
Calcium/potassium	15:1

Organic matter is 60% carbon. When chemical fertilizers are applied, increased productivity occurs. This is because chemical fertilisers work in the same way as mind-enhancing drugs work in humans. They speed up activity. The chemical fertilisers cause a rapid break down of the humus in the soil, which releases the minerals that are held within the humus, making them immediately available for plant growth. The problem is that humus is also the food for micro-organisms and when it is broken down, there is nothing left for the micro-organisms and they die. Soil without life is dead soil.

In the 60 years that chemical fertilisers have been used as normal agricultural practice, the level of organic matter in Australian soils has dropped from an average of 5% to less than 1%. In the same time period, the nutritional value of food grown in Australian soils has dropped by 80%. The food we eat today contains 1/5th the nutritional value compared with the food our grandparents ate. It is obvious that there is a correlation between nutrient rich food and the level of organic matter in the soil.

The addition of carbon to the soil revitalises it and stable humus has the ability to last for thousands of years. Continual recycling of organic material helps to maintain good soil biology.

Oxygen is vital to maintain soil micro-organisms and for the chemical processes that occur in the soil. An open soil structure that allows water and oxygen to penetrate deep into the soil is vital to maintain a large number of micro-organisms within the soil.

Hydrogen comes from rainwater. Hydrogen is an acid element and pH is a measure of the hydrogen stored on the clay colloids. Hydrogen is not a nutrient, but rather a soil activator and some is necessary for regulating physiological processes in the soil. As roots absorb nutrient ions and exchange them for hydrogen ions, more and more hydrogen accumulates and the soil becomes more and more acidic unless something is done to reverse this.

Nitrogen comprises 75% of the earth's atmosphere and is the most important nutrient required for plant growth. It forms 16% of all plant proteins and is a vital component in chloroplasts – the factories that synthesies energy from sunlight. Nitrogen management is vital for both profitability and sustainability. Where there is an excess of nitrogen in relation to other nutrients, pest and disease problems are likely to occur.

Nitrogen levels during the early stages of growth determine the final yield. Nitrogen excess in the early stages of plant development causes the plant to be "top heavy". Leaves and stem development get out of balance with root development.

Nitrogen forms the basis of amino acids, the building blocks of life. It is an essential constituent of nucleic acids and co-enzymes. It occurs in the protoplasm of cells and is an essential part of protein. It determines food value. Nitrogen is extremely important in the production of chlorophyll.

Where do the other elements come from?

Elements join together to create mineral compounds. Minerals are the end product from the breakdown of rock and organic matter. Some minerals contain only one element, others are made from a combination of several. The mineral content of soil is directly related to the origin of the rocks from which it originates. Soil derived from volcanic rock is highly mineralised but even so, it will be deficient in some of the essential minerals required for optimal plant health.

Weathering is the term used to describe the breakdown of rock into its component parts. There are two forms of weathering: physical and chemical.

Physical weathering occurs because of some form of abrasion. Airborne sand is an abrasive agent, which breaks down rock. Ice glaciers have, in the past, been major abrasive agents. Heat and cold cause rock to expand and contract and this causes rock to shatter. Roots from trees grow into tiny pockets and force rocks to split.

The word chelation is derived from the Greek word, meaning claw. Lobsters grip onto their food using their claws. The same process occurs in soils. Chelation is a process that causes chemical weathering of rocks.

Chelating agents like peptides, extract metal ions from rocks. Most mineral complexes are bound in some form of a chelate ring. Minerals can be gripped by humic acid or protein. Fungi hyphae act as chelators of calcium.

Some elements, for example silicon, occur in great quantities. Some occur in minute amounts. Elements that occur in only tiny amounts are called trace elements.

Not all rocks contain all elements. Australian soils are, for example, generally deficient in selenium.

Leaching (removal of water soluble minerals) is a natural process because minerals dissolve in water and are carried away. Leaching has been accelerated by modern agricultural practices where highly soluble, acidulated fertilizers are applied.

Chemical fertilizers are made of "pre-digested" mineral inputs, which quickly become “complexed” with other elements, making them unavailable for crops. Australian soils are very high in phosphorous because of the amount of super phosphate that has been applied, but this phosphorous is tied up and is not available to plants.

MAJOR ELEMENTS: CALCIUM, PHOSPHORUS, SILICON MAGNESIUM, POTASSIUM, SULPHUR

Carbon, oxygen, hydrogen and nitrogen are the four **free** elements. Calcium, phosphorous, magnesium, sulphur, potassium and silica are other very important elements because their role is to build plant proteins, cells walls and mechanical structures such as leaves and branches. They are essential for plants to grow and reproduce.

The important thing to realise is that no element works alone. Biological processes involve many different elements working together, all of which have a different role to play. Soils are not static. They are constantly working to achieve balance but the efficiency of the soil is only as good as the element that is in shortest supply compared with what is needed when the soil is properly balanced. Adding more calcium to a soil that already has sufficient, is not going to improve anything. Your challenge is to identify the deficiencies and provide these.

Calcium is found in **every cell** of plants. Plants are made up of 2% calcium. Calcium is never found in nature in a pure state but complexes with other elements to form over 1,250 naturally occurring compounds.

Regulation of the permeability of cell membranes depends on calcium saturation of plant sap. In plants, calcium helps plants

survive periods of drought, excess heat and cold by building thicker cell walls. Calcium is associated with production of plant pectin which provides energy when eaten by animals and humans and is incorporated in compounds that protect plants from insects and diseases.

Without calcium, plants will not grow because calcium is needed for cell division and cell elongation. Because calcium is relatively immobile in plants, deficiencies will occur in the younger leaves, which is significant because calcium is important in cell division in the growing tips of stems and roots.

Calcium also strengthens cell walls of microbes making sure they are resilient enough to colonise and proliferate in the soil. Cell strength is very important for single-celled micro-organisms. In the soil, fungus wraps its hyphae around calcium ions holding onto them tightly because they are of such importance to the fungi.

Calcium is an essential nutrient required by plants. Plants absorb more nutrients when calcium is available in the soil. Higher fertilizer efficiency, better soil tilth, better water penetration, improved plants health, reduction in insect attack and soil conservation, increased yields and decrease in need for chemicals are some of the indirect benefits. The benefits occur as a consequence of increased microbial activity that results from optimising calcium levels as long as sulphur is also present.

Calcium is part of a larger system. It does not act by itself. It acts in combination with other minerals and with the micro-organisms in the soil.

Symptoms of calcium deficiency are first seen in younger leaves. Other symptoms include:

- Stunted root systems
- Blossom end rot in tomatoes and capsicum
- Tip burning in strawberries
- Premature flower drop and poor seed set
- Susceptibility to root diseases
- Cavity spot in carrots

Nutgrass, cobbler's pegs and dandelions are signs of calcium deficiency.

Phosphorus: Every process in a plant relies on a source of energy. Adenosine tri-phosphate (ATP) is the energy currency of all living cells and phosphorus is the key element in ATP. Phosphorus is a primary catalyst and is at the core of a plant's energy molecule, ATP. ATP can be likened to the boosters and cables of our energy supply system transporting energy to convert photosynthetic energy into glucose and then into complex sugars and starch. It also provides the energy that is used to access stored energy!

ATP is used in photosynthesis to harness the sun's energy and convert it into chemical energy. Phosphorus provides fuel for growth and production. Peak energy is required for shoot and root growth, especially during the root system establishment phase. During pollination, phosphorus is required to cater for the huge drain on energy resources. Another peak demand time is when the plants start forming seeds.

When they have a good energy supply, plants can fend off attack from pests and diseases because a good supply of

phosphorous means increased sugar levels. Surprisingly, high sugar levels are not attractive to insects, which have an extremely rudimentary digestive system. High levels of sugar convert to alcohol in the insects and poison them.

A healthy plant synthesises a huge number of biochemical compounds within minutes of an insect attack and these will actively ward off attacking insects and disease. These compounds make the plant distasteful to insects or make the cell walls stronger. Sometimes anti-fungal compounds are produced which actually kill fungi. These same bio-chemicals give food flavour and are beneficial in the human diet.

Early root establishment is the most vital period in determining final yield because plants make many vital decisions during their first eight days of life and trees determine their size and productivity during the first eight weeks. Plants release microbe food from the roots sending it from the leaves to encourage microbes to stay around and multiply, thus ensuring increased nutrient availability and disease suppression.

Phosphorus is also present in cell membranes and is responsible for directing what comes into the cell and what leaves.

Typical symptoms of phosphorus deficiency include**:**

a) Stunted root and shoot systems
b) Leaves which lack lustre
c) Yellowing of leaves
d) Blue green or purplish leaves

Magnesium is vital for both seed germination and for the photosynthesis process, which accounts for 95% of crop weight. In plants, magnesium is found in the seeds and foliage and is vital for seed germination. It regulates the uptake of a number of important elements into the plant system. Magnesium is the **carrier for phosphorus**. The chlorophyll molecule in plants closely resembles the haemoglobin molecule in human blood, different only in that magnesium is the **core element of chlorophyll** where iron is the core mineral of blood. In this role it is responsible for tapping into the sun's energy via the process of photosynthesis.

The calcium/magnesium ratio is the most important ratio in mineral management. In sandy soils the ideal ratio is 4:1. In clay soils the ideal ratio increases to 7:1. Magnesium is often deficient in low pH soils and where calcium applications have stripped magnesium from the clay colloids.

Magnesium is involved in the activation of over 300 enzymes and bio-chemicals. It is vital for the synthesis of amino-acids, vitamins, oils, fats, sugars, pigments and carotene. It regulates the uptake of a number of elements into the plant, including calcium.

Typical symptoms of deficiency of magnesium in plants include:

a) Premature leaf drop
b) Abnormally thin leaves
c) Mottling or striping between the veins in leaves. Older leaves are affected first.

Potassium is not part of the plant structure nor does it form into compounds. All living systems involve a continuous series of chemical changes and to assist these complicated reactions, catalysts speed up the process. These catalysts are called enzymes. Potassium is involved in the regulation of

approximately 50 enzymes in plants. For example it is needed in the conversion of nitrogen into protein. It facilitates the movement of sugars and starches and is therefore important for fruit size. It enhances stomata regulation, enhancing oxygen uptake and water retention. In plants, potassium regulates osmotic pressure in cells.

In plants, potassium is second only to nitrogen in terms of the amount required by plants. Avocados and bananas actually need more potassium than nitrogen.

Typical symptoms of potassium deficiency include:

a) Marginal scorching of leaf edges and tips
b) Slow growth
c) Weak stalks
d) Shrivelled seeds and fruit
e) Small fruit with poor colour and no taste
f) No disease resistance.
g) Unevenly coloured tomatoes and light brown burning of cucumbers

Sulphur is essential for the synthesis of enzymes, vitamins and two important amino acids, methionine and cysteine, which are the building blocks for virtually every plant protein. Fruit quality is directly related to the presence of sulphur and all fruits improve in taste and keeping qualities when sulphur is available in adequate quantities. Sulphur also increases the protein content of crops, and improves root development, essential to the successful cultivation of carrots and parsnips.

Ideally plants will take up sulphur at the same levels as phosphorus. Sulphur deficiency causes young leaves to be pale green and when the deficiency is severe, leaves will stand upright with a cupped appearance or they will curl in.

The downside of sulphur's ability to bond with other elements is that since 1954 when chemical fertilizers started to be used world wide, sulphur has bonded with chemical fertilizers such as ammonium nitrate and ammonium sulphate and in doing so, has become unavailable to plants.

Silica is the second most abundant mineral on earth but it does not occur in a form that is readily used by plants. Silica dissolves in water to form silicic acid, which is the form that can be used by plants.

The presence of this mineral makes cell walls tough and resistant to attack. Found in the epidermal cells of plants, silica acts as a barrier and repellent against invading insects and fungi, aphids, sucking insects and powdery mildew. Apart from directly resisting plant infections, silica stimulates the creation of other disease resistant compounds such as polyphenol compounds. Silica has been found to accumulate around diseased parts of a plant, indicating that its role is both preventative and curative.

Once silica is incorporated into the cells of a plant it is immobile so silica needs to be in constant supply. It is found in abundance in root cells where plants are most exposed to pathogens and parasites.

Silicon facilitates the uptake of nitrogen, potassium, zinc and magnesium. Concentration of chlorophyll as well as utilization of carbon dioxide is directly affected by the presence of silica in

plants. This is why silica deficiency can cause malformation of young leaves and either deformed or missing fruit.

Silicon reduces the negative impact of elements that are present in high quantities and improves a plant's resistance to water deficiency because heavy concentration of silica in the outer cells of plants reduces transpiration levels.

The Importance of Maintaining Balance in Agriculture

Universe operates under the law of alignment and balance.

Balance for the land is the key to agricultural success. In nature, no area contains just one or two different species of plant. Diversity creates balance and the greater the diversity, the greater the ability of the land to withstand stress and be productive.

When we grow some crops, some trees, some herbs and flowers, the soil retains its balance. A balanced yield from soil creates balance in the soil. The micro-organisms and creatures within the soil are dependent on balance. Kill them and the soil, which is a living system, also dies. Soil regeneration and growth depend on balance.

The first rule of ecology is that everything is connected to everything else, so that when one component changes, everything else changes in response. In nature, everything is in balance. When we impose on natural systems, we run the risk of upsetting that balance so the key is to imitate nature as closely as possible.

The primary activity in soil is the breaking down of organic matter and the release of plant nutrients. This provides the food for soil micro-organisms. Ultimately humans, forests and farms all rely on soil organisms for life.

Soil retains its balance and its ability to bear fruit when it remains unpolluted. When we poison the soil with chemicals and insecticides, mankind is also adversely affected. Poison the soil and mankind becomes poisoned. What exists in the soil ultimately exists in man.

Poison the soil and you poison the water upon which everything depends. Poisons ultimately end up in the rivers and oceans. They destroy the balance there, causing a depletion of the apparently never-ending abundance of fish. If poisoning of the soil, water and air occurs at the current rate, people will become more and more sick and eventually die. Earth cannot sustain itself in its current state and mankind will die because deep down, he knows he has chosen to do this to learn the lesson that taking care of what is freely given is a responsibility that we cannot take lightly.

There are ways of feeding man without poisons and without the need to employ vast armies of machinery. These ways are known and there is certainly movement away from "chemical farming" and towards a variety of forms of "biological farming". The move is accelerating because of the rapidly escalating cost of oil, which is the raw material for chemical fertilizers, herbicides and pesticides, as well as being the fuel for

machinery. Large chemical and oil companies are resisting the changes and are concentrating on increasing yields by means of scientifically based genetic engineering "solutions" but there is much evidence to suggest that this is a potentially dangerous quick fix.

What the "quick fixers" do not realise is that life on Earth is the means to achieve balance between the spiritual and the material worlds and our ultimate goal is to create "Heaven" on Earth as a demonstration of who we are, and as a visible, solid reminder of our individual greatness. "Quick fixers" act as if they are disassociated from the Earth's systems and have the power to over-ride the laws that apply in nature. Ultimately, the outcome from such actions is annihilation because, unless we validate Earth's role as a life support mechanism, we place it in limbo, apparently separate from us and without a role to play and Earth responds by creating climatic disasters.

Reliance on large scale, mechanised farming methods based on inputs of chemical fertilizers, pesticides, fungicides and herbicides has upset the balance of huge, formerly productive areas of the world.

Canada has lost half the organic matter from its black prairie soils in the past 70 years. In Jilin, China's Granary, large areas of fertile and productive black soil has been eroded. The black soil layer has been reduced by 50% according to a report by the Chinese Academy of Engineering. Large areas of Australia have become salt encrusted wastelands because of large-scale monoculture or poor irrigation practices.

Chemical fertilizer is defined as material of wholly or partially synthetic origin that is added to soil to sustain plant growth. Artificial fertilizer contains acids, such as sulphuric acid and hydrochloric acid, which tend to increase the acidity of the soil. The ideal soil pH is 6.4. Plants grown in soil that has a pH of less than 6.4 are susceptible to disease.

Large scale chemical farming's primary outcome is to kill soil micro-organisms. Pesticides and fertilizers kill them. Turning soil upside down kills them. Removing oxygen from soil by compaction kills them. Flood, fire and contamination by toxic substances all kill them. Removing organic nutrients via food harvesting without returning the organic nutrients to the soil, kills them by starvation.

In 1971, 70,000,000 tonnes of chemical fertilizers were used worldwide. In 2007, 170,000,000 tonnes were used. Chemical fertilizers, heralded as the "Green revolution" that was destined to save the world from starvation, had some unexpectedly disastrous consequences.

•The USA uses ½ billion kilograms of synthetic pesticides per year. Thousands of domestic animals and natural predators are poisoned annually. USA data shows that 18% of all pesticides and 90% of fungicides are carcinogenic.

• Dead zones, areas in which fertilizer runoff has created algae blooms that suck oxygen from water have developed. Huge areas in Europe and along the eastern coast of USA are affected.

• Studies of water polluted by agricultural chemicals at concentrations that mirror levels in groundwater show disturbing biological effects suggesting that children, and foetuses are at risk from water contaminated by a mix of chemical fertilizers and pesticides. Their influence on

developing neurological, endocrine and immune systems leads to a change in ability to learn and in patterns of aggression. The study reported that influences on the endocrine system, the system of glands that secrete hormones into the bloodstream, have a cascade effect, spilling over to the immune system to affect foetal brain development.
(Dept Zoology and Endocrinology Laboratory, University of Wisconsin.)

• NPK fertilizers contain salt, which kills living organisms in soils.

• There are concerns about arsenic, cadmium and uranium accumulating on land that has been treated with continued applications of phosphate fertilizers. Phosphate minerals from Nauru and Christmas Island contain 100 mg of cadmium per kilogram.

• Plants feed by releasing root exudates of precise mineral composition to activate soil fungi and bacteria. These micro-organisms solubilize the precise elements that the plant requires. In this way the plant can take what it needs from a smorgasbord of available nutrients. Exudate composition varies throughout the life of the plant and any stress imposed on the plant, results in compensatory changes in exudate composition. Soluble chemical fertilizers override a plant's ability to take from the soil what it needs to practice "self medication". The overriding of a plant's ability to self-select what it needs in order to thrive, explains the prevalence of pest attack and disease in crops fertilized by chemicals.

• Generally, healthy soil contains enough nitrogen-fixing bacteria to supply the needs of growing plants. Continuous use of chemical fertilizers destroys the nitrogen-fixing bacteria and also affects plant health. Fungus and bacterial disease, resulting from a lack of trace elements, occurs in soils regularly dosed with chemical fertilizers.

Chemical fertilizers increase productivity initially by speeding up the breakdown of organic matter in soil. Since they were first introduced, organic matter in soil has declined from 5% to 1% on average. Canada's prairie soil has lost half its organic matter in forty years.

If we are to reverse these disturbing trends, we have to start doing things differently. The methods described in the programme are designed so that you can do what is needed to allow Earth to move back into balance.

About Learning

Learning does not occur passively. Learning requires action: **doing** something with new information. Learning involves interaction. It is within a framework of activity and action that learning takes place. People sometimes think that reading something is sufficient and that they will retain the information they have read. Unfortunately this does not happen. Unless we use new information, we will probably forget it. We can use information by putting it into practice, and by recalling it in answer to questions or by problem solving.
This study programme provides you with a variety of ways to use information you are given. If you follow the guidelines you will retain a great deal and will find satisfaction in knowing why things are done as they are. Questions are used to highlight main points.

Review Exercises

The following exercises will give you the opportunity of testing how much information you have retained and will help refresh your memory of what has been covered. Refer to your notes to answer questions.

Task 1

1. We talk a lot about the damage caused by chemical fertilizers (the NPK approach). Why do they boost productivity when first used? What is their long-term effect?

2. What are three functions of minerals in plants?

3. What are the free gifts provided by Nature? How important are these in terms of crop production?

4. What is the critical factor we need to take into account before we can be sure that our crops receive their free "gifts"?

5 What factors could account for mineral deficiencies in our soils?

6. What is the role of soil organisms in terms of carbon availability?

7. Why is nitrogen such an important element?

8. Working to build an "ideal" soil involves adding nutrients in the right proportion. Why is balance so important?

9. What facts support the idea that calcium is critical for plant health?

10. Phosphorus is central to the energy molecule of plants. What plant processes use up high levels of energy?

11. Magnesium has a variety of roles. What, in your opinion, is its most important role and why?

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12. An enzyme is a complex protein that promotes a specific biochemical reaction by acting as a catalyst. Potassium regulates approximately 50 enzymes in plants. Identify a biochemical reaction that occurs in plants because of the presence of potassium.

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13. What are the signs of phosphorus deficiency?

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14. What is the relationship between silica and pest damage.

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Task 2

Memory test

Read each statement and decide whether it is true or false.

	True	False
1. 95% of all plant input is provided free.	____	____
2. C, H, O and N are absorbed regardless of the balance of the remaining elements.	____	____
3. Calcium is found in every cell of all plants.	____	____
4. Calcium is a component of over 1,250 naturally occurring compounds.	____	____
5. Calcium is a carrier for phosphorous in seeds.	____	____
6. Phosphorous is at the core of a plant's energy molecule.	____	____
7. Magnesium is the core element of chlorophyll.	____	____
8. Sulphur deficiency causes leaves to curl.	____	____
9. Calcium is needed for cell division.	____	____
10. Phosphorous governs the inputs and outputs from cells.	____	____
11. Silicon is a readily available plant food.	____	____
12. Phosphorous is present in cell membranes.	____	____
13. pH is a measure of the concentration of nitrogen stored in the soil.	____	____
14. Energy is generated as a result of processes caried on within and between cells.	____	____
15. Cell vitality depends on chemical reactions that take place when minerals are present in the correct balance.	____	____