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By

Sandra Kirk

PO Box 37
WOODGATE QLD 4660
Tel: 07 41265202
Email: skkirk@hotmail.com

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Project Leader's Name: Jim Geltch
Australian Nuffield Farming Scholars Association CEO
PO Box 1385
GRIFFITH NSW 2680
Ph: (03) 5480 0755

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Consumer demand is the driving market force in world wide agricultural production as we know it. Producers are faced with ever increasing pressure to produce a premium grade product that retains a high level of nutritional value. This is becoming increasingly more difficult to achieve given the conventional farming practices of producers. Farmers need to find a solution to their predicament.

Through balancing the soil's physical, chemical and biological properties, farmers can create an environment whereby they maintain a healthy system. Declining soil biology is the fundamental problem that is plaguing the majority of farms world wide. Yet the methods of restoring soil biology are so simple and affordable, it is a change farmers cannot afford not to make in order to remain viable.

Soil can be balanced by understanding and employing a few simple key practices, which can include:

- Regular soil testing;
- Applying compost;
- Application of Compost Teas and inoculums;
- Implementing crop rotation systems;
- Employing sound farm management practices.

Through introducing a farming system, which employs these key practices, the remainder of the system will automatically follow – the development of healthier crops that are more resilient to pests and diseases and with greater nutritional value. It is vital that the concept of our food being dependant on our soil is understood, and it is imperative that action be instigated now to prevent any further decline in the health of human life's greatest asset. It stands to reason that improving the soil will improve the quality of crops grown in it. If the crop quality is improved it is only logical that whatever consumes that crop will be healthier as well.

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Mr Liford Edwards from Harvester Enterprises and Mr Graeme Sait from Nutri Tech Solutions for their continued inspiration, encouragement and support.

All the people I met with during my personal study. I am indebted to you all for your time, knowledge, friendship, support and encouragement.

Finally, my parents for teaching me a couple of invaluable lessons in life:

- Think for yourself and question.
- Do and say what you believe – don't ever be a "yes" person for the sake of it.

INTRODUCTION

Modern-day producers world wide, have been forced to consider a number of questions in relation to their farming practices based on consumer demand. These questions have included:

- How can I improve the flavour and shelf life of my produce?
- How can I grow nutrient dense food without using surplus quantities of insecticides and fungicides?
- How can I improve production whilst cutting my costs, ensuring I care for the environment and remain profitable all at the same time?

While many producers have placed the solutions to these questions into the all too common 'too hard basket', a select population of the agricultural community has taken up the challenge of finding an answer to this endemic impact plaguing present day agricultural practices.

Founded on the desire to find a 'smarter way of farming', the author of this report examined her own farming practices and began the process of implementing changed practices to address the prevalent flaws in conventional farming techniques. The substantial increases in the costs associated with farming were confounding, including wage increases, compulsory superannuation, holiday leave loading, payroll tax and penalty rates. Coupled with this were the general price increases in fuel, freight, cartons, fertilisers and chemicals, and given that the average market price for produce was returning the same as fifteen years ago, it is understandable why change was inevitable.

The author examined her own conventional farming practices involving a high use of N.P.K. blends and trace elements and a system of dependence on increasing amounts of insecticides, fungicides and herbicides to produce a consumer demanded premium product. This system was not sustainable. Every year greater application of spray was being applied to crops while rates of control over insects and diseases were decreasing. The fact that the soil was being raped of its structure, biology and chemical balance was the main cause of her farming system's predicament.

It was never in dispute that there was a need to plant green manure crops. Forage sorghum was selected for this particular use and was systematically watered, disced into the ground and allowed to ratoon several times a year between crops. Yet irrespective of how many tons per acre of sorghum was produced, the organic matter in the soil would not build up.

AIM & OBJECTIVES

Based on the development of a sustainable farming system by the author and through the opportunity provided by Nuffield and Horticulture Australia, a global study was employed. This study explored the alternatives for producers to reduce their usage of fungicides, pesticides and synthetic fertilisers in agricultural production, while maintaining and enhancing the quality of their end product.

The objectives of the study were to include the investigation into the importance of sound soil biology as the key element of the farming system. Key areas to be examined in relation to the importance of soil in the system were to include:

- The necessity for soil testing;
- The function of compost Teas;
- Soil benefits and disease management through the use of inoculums;
- Benefits of applying compost;
- Soil structural management;
- Crops selection and rotation;
- Tillage practices;
- The importance of pH in soil and crops;
- Function of foliar fertiliser.

These topics in relation to the overarching principle of sound soil biology management were investigated through the tour, examining novel based farming practices and consultation with progressive industry personnel. This report will examine the findings of this study in relation to the preconceived knowledge of the author and demonstrate the significant crop benefits that have been achieved by farming with a focus on sound soil biology across a host of commodities. The findings of the study largely confirmed the preconceived concepts that were established prior to undertaking the study, however a number of new concepts and practices in relation to the techniques were discovered through the opportunity to examine how the operation of these practices are undertaken in other countries.

FUNDAMENTAL PRINCIPLES OF PLANT PRODUCTION

This study was employed on the fundamental basis of the common ignorance of the elementary principles of plant photosynthesis. It is commonly accepted that 30% of the sugars and starches produced daily by plants are released via their roots into the root zone. The reason for this process is the need for the plant to feed the biology in the soil. It is the microbes that dissolve the nutrients into a form that can be used by the plant. The plant feeds the microbes and the microbes supply the food for the plant. The more diversity and the greater the number of microbes, the healthier the plant. A basic component that is all too often overlooked, is that 95% of the plants weight is made from photosynthesis and only 5% of the energy requirements is supplied in fertiliser.

While there is no 'silver bullet' solution to this issue, there is a *magic word* that is regularly ignored and that is BALANCE. Balance of the three equally important categories that comprise the soil; physical, chemical and biological properties, is the key to unlocking the complexities of the farming system - a simple solution to ensuring that a sustainable agricultural system is easily achievable. The break down of the roles of these soil categories include:

- Physical Properties – incorporating the structure, texture and tilth of the soil and impacts on aeration, drainage and compaction;
- Chemical Properties – incorporating the minerals and trace elements;
- Biological Component – involving the soil organisms and their requirements for humification of organic matter, which improves the water holding capacity and nutrient storage.

It is only when these three categories are in balance with each other and within themselves that producers have any chance of improving the quality of their soil and the products they produce in it. It is therefore necessary that soil is balanced through the systems approach of integrating:

- Soil Testing
- Composting
- Compost Teas/inoculums
- Crop rotations
- Green manure crops
- Farm management practices

It is common sense that the majority of consumed food is dependant on the soil in which it is produced, and it is therefore imperative that action be taken to prevent any further decline in the health of a farmers' greatest asset - their soil. It stands to reason that by improving soil, it will improve the quality of crops grown in it and as such whatever (or whoever) consumes that crop will be subsequently healthier.

BALANCING YOUR SOIL

Soil Testing

The first rule to follow when aiming to balance the soil is to obtain a good accurate soil analysis. Producers need to know what the levels of nutrients are in their soil and the availability of these nutrients to the plant. The ratios between the elements are important as are the base saturation levels.

Base saturation levels are an important indicator of the productivity of the producers' soil. The major cations – calcium, magnesium, potassium and sodium all have to be in balance with each other according to soil type in order for the other elements necessary for growth to be freely available for uptake by the plant.

There is considerably more to fertilisation than the traditional N.P.K. levels. All elements must be present and in balance for the system to work to the best of its potential. Ratios between calcium / magnesium and potassium / phosphorous, for example, need to be considered to ensure the balance of the soil.

While talking to the larger percentage of farmers, if soil tests were mentioned, a common response was "my N.P.K. is OK., my calcium is OK as the pH is right." However, magnesium is reputed to have more impact on the pH of the soil then calcium in addition to the influence that other cations have. It is widely regarded that a pH of between 6.3 to 6.8 is ideal. If the pH alters greatly either way, producers can increase the risk of "tying-up" trace elements and killing off some of the biology that is not capable of surviving in these extremes.

After receiving results, the producers' consultant should be able to explain all the details of the soil test and the recommendations, which should address all shortages and excesses to return the soil to 'balance'. Preferably, there would be an added addition of biology that would assist in kick starting the growing phase of the crop.

Compost Teas & Inoculums

A Compost Tea is a process in which microbes are extracted from the compost and allowed to multiply in aerated water with a suitable food supply. If good quality compost is used, a wide diversity of fungi, bacteria, protozoa and nematodes should be present. As long as the system remains aerobic (oxygenated) there should only be beneficial organisms present, if it was ensured that the brewer was thoroughly cleaned before use.

There are a variety of "brewers" available on the market. Fibreglass or plastic appear to be the preferred material for the construction of the tank and it is more practical to have curves rather than corners for cleaning purposes and as the curves minimise the areas of poor air circulation. It is also imperative for the Compost Tea process that the oxygen supply is kept at around 12 -15%.

The Tea is mixed with water and foliar sprayed or fertigated. Extensive trials with Teas have been undertaken by the author, with both methods producing good results. Ideally a Tea is most effective when it is sprayed in the evening with a fine mist by using low volume nozzles not exceeding 60 p.s.i. and aiming to get at least 70% coverage on both sides of the leaf.

Through trials conducted, it has been discovered that the foliar spraying of Teas at a rate of 75 litres per sprayed hectare gives good disease prevention and suppression in tomato crops. This was based on a spraying schedule of every five days and reduced to two or three days until control was achieved, if any sign of disease was evident.

The use of foliar sprays of different types of predatory fungi and bacteria to help with controlling disease outbreaks has also proven successful. These inoculums are specifically bred to out compete and consume the pathogens and work well in conjunction with the Teas.

The biology of the author's soil was virtually non existent prior to the implementation of these sustainable 'balanced' practices. The farming characteristics including the high use of salt fertilisers, insecticides, fungicides and herbicides had decimated the vital soil biology. Yet the problems created by these practices are not irreversible, and the quickest and most economical way to re-introduce the microbes into the soil is through the use of Teas. Testament to this ideology is the author's own farm, where every week she applied 100 litres of Tea per hectare through the irrigation system.

A fungal inoculum was also used for nematode control and this produced impressive results. There are a range of soil inoculums in addition to foliar types available, depending on crops grown and disease prevalence. If a producer worked on the theory 'prevention is better than cure' and sprayed and fertigated on a regular basis with Teas, they would build up their beneficial organisms, which are then present in the soil and on the foliage and working all the time.

The foods for bacteria are simple and are easily digested like molasses, sugar, fish and fulvic acid. The fungi prefer the kelps, humic acids and aloe vera solutions. All of these feed the plant as well with enzymes and nutrients. The fulvic and humic acids provide increased nutrient storage as well as chelating the inputs.

While producers need a diversity of microbes in their soil, all plants have a preferred balance between fungi and bacteria. Producers need to find out if the crop they are growing prefers bacterial or fungal dominance in the soil. Whilst it is imperative to have all micro organisms in the soil, the consideration of the plants natural growing conditions gives an indication as to their preference or desired balance.

By applying Teas you have the ability to introduce beneficial organisms into your soil. The addition of suitable food sources helps ensure the survival and multiplication of these organisms, as well as nurturing the naturally occurring population still in your soil.

Case Study – Tea enriched Grass for finishing Beef; Granger, Texas

Farming in a harsh environment with an annual rainfall of less than 30 inches, Mrs Betsy Ross from Granger, Texas had always found it difficult to finish her beef on pasture. Her expenses were starting to beat her so she knew she had to change her practices. She decided to use Compost Teas to see how they would work. Since applying Compost Tea sprays to her pastures, she can now finish her stock over a 90 day period with an average weight gain per head of 3.5 pounds per day. She direct markets "Grass Fed Beef" and has a growing market for her product. Since using the Teas she doesn't use any herbicides or synthetic fertilisers and has been able to go to "no till" as she no longer has a compaction problem – her earthworms and other microbes do the tilling for her and there are dung beetles active in every pat.

Once her soil regained its balance the weed pressure decreased – this occurrence has been noted on the author's own farm as well, and as hard as it may be for some to believe, it does happen. Dr. Elaine Ingham did an experiment and proved that the soil needs fungi in order to have calcium retention and most weeds do not flourish in these conditions. Since using the Teas the fire ant population on Mrs Ross' pastures has decreased by about 90%. She believes that with more regular spraying she will gain better control over ticks as well. She sprays her herd with Compost Teas to help reduce flies and is impressed with the results.

Mrs Ross commented that her cattle had changed their grazing habits since using the Teas. They no longer rest during the heat of the day and she attributes this to the increased growth in the pastures, and the improved structure of the soil that keeps the ground cooler through summer. Her cattle were healthy, with shiny hooves and coats and not a "snotty" nose or runny eye in sight.

As a further example of the potential of Teas, Mrs Ross' brother runs cattle in desert country in Sonora in S.W. Texas. He sprayed half of one of his blocks with a compost Tea, and following rain 2 weeks later he had a look to see if there was any difference. Visually both the treated and untreated side looked the same, but when he dug out some of the pasture from both sides, the treated side had 3 times the root mass.

In addition to applying the Teas to her pastures and cattle, Mrs Ross had been contract spraying Compost Teas for other producers in her area and has achieved some truly remarkable results. Figure One below visually illustrates the potential benefits of Compost Tea application on Pecan nuts from a neighbouring property. The Pecan nut on the left was grown using the conventional farming practices of the property and was sourced from the control area. The middle nut had been grown with an added input of hydrolosised fish while the nut on the right was sourced from the area treated with Compost Teas and the hydrolosised fish.

Figure One: Comparison of Pecan Nuts farmed using conventional methods (left nut), hydrolosised fish applied to the soil (middle) hydrolosised fish and Compost Tea applied to the soil (right).

Composting

Nutrient recycling is what Mother Nature does best. Everything that comes off the soil is returned to it in some way, shape or form - nothing is wasted. This keeps everything in the soil in balance. As the leaves, bark, flowers, bird and animal droppings and the bones and hides of animals fall to the ground, billions of micro-organisms decompose them and each other in the manner intended. All the nutrients it took to grow these plants and animals are recycled and returned to the soil in a form available to the plants.

As described by Mid West Bio-Systems, "Compost is the stabilised and sanitised product of microbial and thermophilic decomposition and the build-up of plant and animal feedstock. Humification is where material is passed through the stomach of microbes for more than one generation."

Producers need the plant residues to be ingested by microbes to recycle the nutrients. Without microbes there would not be a build up of organic matter in the soil. Generally speaking, most composters agree on the following basics for turning out a high quality compost.

- Recipe
- Aeration
- Temperature
- Moisture Management
- Humification / Curing

Recipe

This involves the materials used as the foundation of the compost. A carbon to nitrogen ratio ranging from 25:1 to 30:1 is commonly accepted as the ideal. The more diverse the ingredients, the better the quality of the compost that will be produced. An addition of clay at the rate of 10% of the volume of the pile is common practice. This increases the nutrient and moisture holding capacity of the pile. It is also important to have all the ingredients of the compost finish their decomposing cycle at the same time. This may mean starting the decomposition of some of the carbon inputs prior to putting the pile together.

While building the pile it is necessary to take into account the type of materials being used. Good porosity in the pile for aeration and moisture control is required. If all the particles are small the pile will tend to pack down with poor air circulation and anaerobic conditions may occur. All materials must be thoroughly mixed together.

Aeration

This process is to allow oxygenation of the composting materials and to remove carbon dioxide from the pile, in addition to cooling the pile down during the decomposition phase. Beneficial organisms require oxygen to survive. The carbon dioxide levels will be higher in the first couple of weeks due to their high number and the activity of bacteria during the initial decomposition stages.

Daily recordings of both the oxygen and carbon dioxide levels are required. High carbon dioxide indicates an active microbial population, after aerating with a turner the carbon dioxide levels should have significantly reduced – down to about 2%. Measuring the levels of carbon dioxide is a two fold process that also checks the efficiency of the turner – if the carbon dioxide can't escape the oxygen can't get in.

Temperature

The temperature of the compost can be expected to reach 75 to 85 degrees Celsius during the first couple of weeks. Once the temperature goes above this, there is a strong possibility of killing the microbes needed to breakdown the materials being composted. Through using a turner, the pile can be cooled down. Temperature also reduces after the initial decomposing phase.

Moisture

It is important to maintain the moisture levels of the compost at around 45 -50%, as it is difficult to wet a pile once it is established. The moisture needs to be evenly maintained throughout the pile. The Aeromaster series of compost turners produced by MidWest Biosystems in Tampico Illinois, has the ability to spray water into the pile while it is being turned; this ensures all particles are moist and evenly covered. This system also makes it easier to thoroughly coat all particles with inoculums when they are added.

Humification/Curing

The composting materials are required to finish the initial breakdown phase at the same time to ensure the pile doesn't continually heat up to the higher temperatures of the first few weeks. There are different organisms responsible for each stage of the composting cycle and they need different conditions to work effectively.

The simple compounds that are produced during the decomposition phase are now converted into biologically stable humic substances. Compost is generally considered to be finished when there is no decomposing of material and the pile is biologically and chemically stable - the temperature and oxygen levels remain constant without turning.

Crop Rotations & Cover Crops

Cover crops are grown to protect the soil from erosion, to increase the organic nitrogen in the soil by growing legumes and to help slow the proliferation of weeds. By growing these crops you are ensuring the survival of the soil biology and helping improve the structure of your soil. All available nutrients are used in the production of the cover crop and when it is turned back into the soil the biology can reconvert the decaying matter into plant available nutrients.

Monoculture is renowned for breeding specific weeds. Through rotating crops, producers can decrease the number and type of weeds as they significantly alter the soil conditions by introducing a new crop. This practice also increases the diversity of organisms in the soil. Growing of allelopathic crops can restrict the growth of weeds due to the toxins they secrete.

Lucerne is a deep rooted plant which can help break down compaction layers in the soil. Compaction layers occur naturally but are commonly caused by farming practices. Frequent travelling over an area and working the ground while it is wet are the main reasons for this occurring. Once the soil is compacted it becomes anaerobic as there is no oxygen in this layer.

By growing deep rooted crops the roots venture deeper into the layers of soil taking oxygen and microbes down with them, over time this will alter the profile of the soil. Deep ripping also mechanically opens up the hard pans and when used in conjunction with selected crops speeds up the process of removing the compacted layer.

Case Study: Cover Crops; Dexter, Missouri

The choice of cover crops by producers needs to be selective in order to benefit the succeeding cash crop to enhance its productivity and nutritional benefits. Mr Carroll Montgomery, an organic grower from Dexter in Missouri had modified his farming practices to use Red Clover as a cover crop before planting Popcorn. Mr Montgomery had trialled the use of Red Clover and discovered that he obtained better mineralisation and heavier ears of up to 115 grams on average in his Popcorn than when the traditional break crops of the area such as Austrian Pea or Hairy Vetch were planted. He felt that it is necessary to vary the legumes grown according to the specific needs of the producer and the climatic conditions of the farm. He advocated the importance of incorporating the mulch into the soil through a method that had the least impact on the earth worms. He strongly promoted the need to have the plant material in contact with the soil for decomposition and nutrient recycling to occur.

Farm Management Practices

Tillage

There is considerable conjecture about tillage and there are an increasing number of people who advocate “no till” as the only way to farm. However, it is the consensus of this report that selective tillage would be a more beneficial approach. The main concerns with the “no till” approach is the high use of herbicides that are used for weed control in the cropping situation and that the plant residue is left lying on top of the soil.

While it is appreciated that the concept of not disturbing the soil and leaving the crop residue on top is aimed at preventing erosion, the structure of soil has been significantly altered by the ways in which we have farmed our land over the past fifty odd years. Producers need to increase the biological activity of their soil so that all nutrients are recycled and the ones “tied up” in the soil are solubilised so the plant can use them. If the physical properties of the soil are improved it will hold together better and resist erosion. Declining levels of organic carbon and organic matter in the soil is a direct result of farming methods.

It is conceivable that the crop residues should be incorporated into the top layers of soil as soon as practical after harvest. The high sugar and starch levels in the residue will help stimulate biological activity. This increase in activity is necessary for the humification of the residue. As it is widely accepted that herbicides have the potential to destroy soil organisms, it is senseless to incorporate a practise that is going to accelerate the decline in the health of the soil.

Case Study: Biological Farming; Grinnell, Iowa

Mr. Bryan Davies was "no till" farming in Grinnell, Iowa and was plagued by decreasing production and increasing inputs every year. Mr Davies was farming with a corn / soy bean rotation that was common in his area and was just about ready to give up farming. His attitude changed, however, when he attended a seminar conducted by Mr. Gary Zimmer on biological farming and decided to give this approach a go. Since then, he has managed to turn his production around and increase his profitability by altering some of his practices, including:

- Deep ripping the soil to open up hard pans
- Grow cover crops
- Use fertilisers that do not harm the biology of the soil
- Incorporate crop residue into the soil
- Sow crops when conditions are favourable – not by the Calendar

In the following photo, Figure Two, two blocks of corn are pictured. The crop on the left is Mr Davies that was grown biologically and the one on the right was grown conventionally by his neighbour. A severe storm had passed through the area and the only corn left standing was the biologically grown crop. The increased mineralisation resulting from a balanced regime of fertiliser and stronger root system, as detailed in Figure Three, saved his crop from the fate experienced by its conventionally grown neighbour.

Figure Two: Comparison of Biologically (left)
and Conventionally (right) grown corn, Grinnell, Iowa

After the photo in Figure Two was taken, samples of stem were removed from each block. The length and thickness of stems were exactly the same, yet the biologically grown stems weighed 67% more than the conventionally grown crops.

Mr Davies soy bean blocks were disease free, yet the blocks around him had large areas that were either dead or dying from fungal diseases. By having a diverse range of micro organisms active in his soil he has found less pressure from fungal and bacterial problems commonly associated with the crops he is growing. He is also enjoying less pressure from weeds with his new methods of farming.

Mr Davies also commented on the general appearance of his crop after cultivating for weed control. Plants use carbon dioxide while photosynthesising and when the soil is cultivated there is a release of carbon dioxide while oxygen enters the soil. The oxygen is beneficial for the microbes in the soil and as the carbon dioxide rises the plant absorbs it and there is an obvious "flush" of growth following cultivation.

Figure Three: Bryan Davies with his impressive corn root structure as a result of biological farming practices, Grinnell, Iowa

Sap pH of 6.4 & Brix Readings.

A meter was developed by Mr. Bruce Tainio from Washington State in America that monitors the vibratory frequency of plants. He deduced that every element has its own vibratory frequency and seeing as all cells in living organisms need an ideal level of all elements, there had to be a link between the vibratory frequency and the sap pH. He discovered a direct correlation between the hydrogen content in the plant cell and plant health. With a sap pH of 6.4 the hydrogen content of the plant sap is approximately 12%.

Sap pH of lower than 6.4 predisposes a crop to fungal infections while higher than 6.4 and the crop is susceptible to insect attack. The author has grown several seasons of tomato crops using this principle in conjunction with testing brix levels, and has found it extremely accurate.

The use of a refractometer to measure brix levels is an easy and reliable indicator of the general nutrition of the plant. The brix reading is a measure of the dissolved sugars and starches in the plant, the higher the brix reading the healthier the plant with improved fruit quality and longer shelf life.

There are monitors available to test the levels of potassium, sodium and nitrogen in the leaf. The calcium level can be read as adequate by the line on the refractometer when reading the brix – the more blurry the line the more calcium, if the line is straight there is a calcium deficiency. Sap pH meters are also available. It is very simple to test the nutritional state of plants when these monitors are in place.

Foliar Fertilising

Foliar fertilising is the fastest way to correct any deficiencies in a crop and relatively small amounts are used when compared to fertigation. The author has been told that calcium does not translocate from the bush to fruit after the fruit is about a fortnight old. In order to get the calcium into the fruit it needs to be sprayed on. Calcium and boron work better when applied together than by themselves. It is simply a matter of ensuring the products used are compatible.

Foliars are best applied in the evening and coverage of both sides of the leaf surface needs to be ensured. Use of an oil as a sticking agent helps prevent drift and provides good leaf coverage. If an element is low in a sap test and that element is applied through foliar spray, within half an hour the reading of that element will have increased.

If soils are unbalanced, the plant cannot absorb the nutrients it requires - foliar applications allow missing elements to be applied to the plant. A good base saturation level of calcium is required for foliars to be effective, with a minimum of 60% recommended. Foliar spraying of kelp, fish emulsions, humic and fulvic acids increase the general vitality of the plant. In addition to supplying enzymes and amino acids to the plant, these products feed the beneficial microbes on the leaf surfaces.

TANGENT POINTS OF STUDY

BioZome

During the course of the study, a meeting was convened with Mr Guy McGowen the President of The Copano Institute in Austin, Texas. His company is marketing BioZome – a microbial soil enhancer. This product is a result of over 40 years of research by Dr. Carl Oppenheimer on microbial ecology. It is a highly concentrated blend of naturally occurring Archaeobacteria collected from areas throughout the world, and bred by Dr. Oppenheimer. The bacteria are blended into a mined mineral matrix and the only processing is in grinding the mineral into a fine powder.

The microorganisms in BioZome are said to greatly enhance the mineralising of rocks and soil, particularly in dissolving silicate rock to provide silica and other elements as well as recycling nutrients from organic matter to form humic soil conditioners. Dr. Oppenheimer told me that this product will destroy all toxins in the soil – it has the ability to reduce everything to its basic elemental state. As this bacteria has no D.N.A. it cannot mutate and it stays in its naturally occurring state. It is capable of reproducing every 20 minutes in a favourable environment.

This primitive bacteria is very effective in low oxygen conditions. As it aids in the decomposition and recycling of organic matter it would be a useful addition to composting. It is said to withstand higher temperatures than all other decomposing bacteria and will still function at temperatures up to 95 degrees Celsius. It has been found that compost piles with these bacteria added at the rate of 90 grams per cubic metre normally require no turning and the decomposition process is greatly accelerated.

Dr. Oppenheimer explained to me that the body wall of these bacteria is very high in iron, and it is the presence of the bacteria in some materials that is sometimes confused with paramagnetism. In order for them to survive and work they need a continual food, water and oxygen supply the same as all living things. These are the same bacteria that he is using in cleaning up oil spills worldwide.

Dr. Oppenheimer put some of this product on a new transmission oil leak on his driveway - he gave it a light scrub with a brush for 15 seconds and then swept it off into his garden bed. There was no sign of any oil on the surface. He assured me that his plants and the soil biology in the garden would not be affected as the bacteria had reduced the oil to basic elemental form and it was not toxic.

Field trials of BioZome are said to have shown improved germination, stronger, healthier plants and increased production. It is applied at around 4.5 kgs per acre and is preferably applied when seeding.

Human Health

Vitamin and mineral supplements are being consumed at an ever increasing rate in our society. People are generally aware that they are not getting the right balance of nutrition from their food. Plant derived minerals are 98% bio-available – this is where we should be obtaining our mineral supply from.

In 1936 the United States Senate Document 264 stated that their farmland was seriously depleted of minerals and recommended that both humans and animals be given supplements. In 1993 the World Health Organisation suggested that the agricultural soils of the world were 95% depleted of essential nutrients. Nutrition and Disease is the title of a 2003 report released by W.H.O. where they found a nutrition link to every disease they studied.

There are a growing number of consultants who are talking about the connection between the health of soil and the health of animals and people. It is imperative for the well being of consumers that producers balance their soils so that they can produce nutrient dense food for consumption.

Consumers need to change their eating habits and how their food is prepared. A trip to the fridge in the supermarket to buy some milk is enough to put your in a head spin – there is full cream, light, trim, calcium added and the list goes on. Whatever happened to plain old fashioned milk?

Paul and Barbara Stitt from Natural Ovens Bakery sponsored a program at a local school in Appleton, Wisconsin promoting healthy food consumption. They supplied the food and a cook to prepare the meals for the children at a school renowned for its bad behaviour, drug and weapon violations, poor grades with high drop-out and expulsion rates. They provided the school with fresh salads, meat and vegetables and whole grain breads along with good drinking water. All the vending machines were removed along with the “fast foods” that were previously on the menu – burgers, fries and burritos etc.

This program started in 1997 and is still operating today. There was a huge difference in the school. Grades improved as did the behaviour of the students – Barbara was a probation officer and had previously found that by putting her “charges” on a diet of fresh fruit, vegetables and meat and eliminating the preservatives and artificial colouring from diets there was a remarkable turn-about in the attitudes and behaviour of all who tried it.

While travelling in America it was all too common to find newspaper reports about schools in different States changing the food they provide for their students. How many of the behavioural problems and learning difficulties being experienced by today's youth can be attributed to poor nutrition?

The first recorded case of coronary heart disease in medical literature was in 1910, today it is one of the leading causes of death in the Western world. Diabetes, Cancer and Alzheimer's are all on the increase in modern society. It is widely accepted that a large percentage of the current degenerative diseases and allergies of today can be attributed to lifestyle, diet, pollutants and toxicity problems.

In the author's opinion, agriculture can lay claim for some of the responsibility of the exacerbation of some of these conditions. The food being produced today does not have the same nutritional value as that of 50 odd years ago. Producers are using increasing amounts of chemicals and synthetic fertilisers on their crops every year. All these synthetic inputs affect the health of the soil and plant and ultimately whatever consumes the product being produced.

RECOMMENDATIONS

Based on the activities of this study and the confirmation of the benefits of the preconceived practices prior to the study, the importance of achieving a balance in the properties of the soil is more than ever apparent. Producers, too often than not, farm based on a reactive step, where by they treat the symptoms rather then the cause. Achieving a balance to address this cause is not rocket science; all producers can implement sustainable farming practices into their operation if they simply accept a change in attitude and understand the importance of good soil biology through balance – the rest will fall into place once this is achieved.

It is recommended that farmers produce their own compost on farm, if the necessary ingredients are available locally. While static pile composting takes longer to mature, it is favoured as it requires less capital expenditure on equipment.

The cost of importing compost to the farm for broadcasting is excessive, and as such is not a viable option. A more feasible alternative is to band it through the use of a belt driven distributor, as worm driven models tend to bind up. If compost is applied, it should be to moist soil and worked in as soon as possible after spreading.

Compost Teas are a very cheap and effective way to introduce a diverse range of beneficial organisms into your soil. It will take time to build up the numbers, as a large percentage of the organisms will be killed off due to the same circumstances that caused the decimation of the naturally occurring ones in the field. Teas need to be applied to the soil as well as a foliar to help protect the crop on a regular basis.

Fertilisers that are friendly to the microbes in the soil should be used. This involves trying to avoid high salt fertilisers, but if they do need to be used, they should be buffered with humates of some sort. Never give a nitrogen supply without a carbon source. For every 5 units of nitrogen that bacteria consume they have to consume 1 unit of carbon. If a freely available carbon source is not available the bacteria will consume the organic carbon in your soil. Use of foliar nutrition is a cost effective way of addressing minor elemental shortages.

High brix levels and plant sap pH of 6.4 will ensure a healthy plant. A healthy plant will have minimal to zero insect or disease pressure given the vibratory frequencies of these plants.

Fallowing of ground should be avoided at all costs. We need to have cover crops of some sort to utilise all the available nutrients in the soil and to keep the biology active. Turning in of the plant residue allows nutrient recycling to occur.

Weeds need to be considered as an indicator of the nutritional and physical health of the soil. Different weeds favour different conditions, when there is an understanding of what the weeds are telling us about the soil it is easier to correct the imbalance that is there. It has been suggested that a spray with calcium nitrate can be more effective in killing weeds than herbicides in some situations.

CONCLUSION

The growing of nutrient dense crops without insecticides and fungicides is possible. With a bit of extra planning and work the amount of synthetic fertilisers used to produce these crops can be dramatically reduced or eliminated. We need to get back to doing things in a manner that "Mother Nature" approves of.

Balancing of our soil in all 3 categories – physical, biological and chemical, is the first place to start. If these categories are not in balance within themselves and each other we are behind the eight ball to begin with.

We need to increase the biology of soils so that the "tied up" nutrients that are present can be accessed. Organic matter and organic carbon has to be increased in the soil - this will only occur if the biology is diverse and active. By increasing the organic matter in the soil, the nutrient and moisture holding capacity will be increased. Given that available irrigation water is limited to non-existent in most agricultural areas world wide, it is imperative that growers do everything possible to maximise the use of this commodity.

Disease and insect attack should be considered as "Mother Natures" way of eliminating poor quality plants. If farmers have everything in balance and work with "Mother Nature" rather then against her, they will find that farming is less stressful, more enjoyable and allows for greater profit margins.

For our own health, and that of the community we need to be able to reduce or eliminate the use of all synthetic products in the production of the food we consume. Food needs to be consumed in its natural state, without all the preservatives and enhancers that are presently added. It is only when this occurs that society will be able to enjoy a healthier quality of life.

It is imperative that animal production is done in a manner that does not rely on hormones, steroids and antibiotics. There are enough serious health issues in society as it is, without having to ingest these compounds every time meat is consumed. Animals should be reared in their natural environment, with well balanced soil and natural foods; they will be healthy and reach their genetic potential without all these unnecessary additives.

Farming needs to be examined in a holistic manner. There is huge diversity in Nature, and this concept needs to be incorporated into our farming methods. There is a need for diversity to balance the system – without this balance farming will continue to produce sub-standard food, health will continue to deteriorate and farmers will simply not be profitable.

Having farmed both conventionally and biologically I can honestly say I would never go back to the conventional methods. Once I grasped a basic understanding of the principles involved, I found it to be a more rewarding and profitable way to farm. I have found the people involved with the biological approach to be far more willing to share experiences and ideas than conventional farmers. No one using this method feels the need to withhold information as they don't consider it necessary to have a "competitive or marketing edge."

All farmers innately know what is right and what is wrong. We need to be happy and balanced within ourselves, at home and in our work environment to function properly. I personally feel that agriculture is at a major crossroad at the moment – we all have decisions to make. Are we going to follow the conventional "high tech track" or are we going to adopt a more sustainable approach? The choice is our own.

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