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Preface

They say "You are what you eat", which is true if you have balance in your diet. That is, if your diet supplies all your requirements for minerals, vitamins, carbohydrate, protein and fat to be healthy.

In the early 1950s I was athletic, a weight lifter and body builder. So I was eating whatever I thought was healthy food. I did not think about food balance or what that balance should be in the diet. I just concentrated on carbohydrate and protein.

Then, when I started to study agriculture at Cairo University I also started to think about balance in the food we eat – what we eat, what we shouldn't eat, and how we can access healthy, balanced food. **It was clear that food can be divided into two categories: Plants and Animal products**.

Group One foods (plants) grow in the soil, so they contain mineral elements and other nutrients such as amino acids and vitamins which are derived from the minerals in the soil. This means that the soil is not just a medium for plant growth, but is also the source of most of the plant's needs, and is therefore also the source of all our needs. So, for foods such as grains, vegetable and fruit to be healthy, they must first be able to meet their requirements in a balanced soil.

Group Two foods (animal products) come from animals that feed on plants grown in soils. This means that to have healthy, balanced animals, they must feed on healthy balanced plant foods that are grown in healthy, balanced soil. **Everything is ultimately produced from the soil**.

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The next thought that came to me was that if we believe God created Adam from the earth, it would make sense that humans consist of the same elements found in the soil, and so they are. Major elements, trace elements and even heavy metals found in people, are also those found in the soil. The only difference is the relative concentrations and the chemical presentation or balance of these elements. This is why, when someone dies and is buried, we say, "Dust to dust."

So, while most of the soil research all over the world concentrated on nutrients (and still does), I recognised that **nutrients are not the only aspect affecting soil balance**, but that soil is a very complex system.

In fact, **it is not possible to supply the balance of nutrients a plant needs if the soil has a poor structure** such as being non-friable (non-crumbling), saline, or heavy clay. Even if plants do grow under these conditions, they will not be healthy, balanced or very productive. Likewise, if you have very friable soil structure but insufficient nutrients, plants will either not grow, or will be extremely unhealthy.

Then, even if you have good structure and good nutrients, there is still a third very important component – soil biology (especially micro-organisms). These creatures are the labour force largely responsible for maintaining the structure in the soil, and for making the nutrients available to the plant. They do this by decomposing organic matter and fixing atmospheric elements such as nitrogen.

It is a combination and balance of all three of these components (structure, nutrients and biology) that gives balance to the soil. This is the reason I call the soil a living system – just as we, who all originally come from the soil, are living systems. And so I began to compare the functioning of soil with that of other living systems such as people and animals.

Just as the human body is built around a structure (skeleton, muscles, organs, etc.), so too the soil is built around a structure of its own. And just as humans and other living systems require a host of micro-organisms to maintain the health and well-being of the living system, so too does the soil. This is why my research has focused on looking at soil from the perspective of these three components. I believe that none of these components should be ignored if there is to be healthy, properly balanced soil.

Since the 1960s my philosophy has been that **plant and animal health (and therefore human health) ultimately depends on balance in the soil**. Healthy soils produce healthy plants, and as animals and people feed on these plants, they will likewise be healthy.

The Mikhail Soil Balance System provides Soil Structure, Plant Nutrition, and Biological Activity.

Soil Structure

With good structure and friability, the soil will be more tolerant of cultivation, retain moisture, drain more easily, remain well aerated, and will provide plant roots with better access to available nutrients to provide for the plant needs. In short, soil balancing will make all other aspects of farm management so much easier.

Plant Nutrition

Providing balanced plant nutrition involves applying ONLY the essential nutrients found to be insufficient for the requirements of the crop. **The only fertiliser used is that which is actually needed**. In this way, the plants will always have enough nutrients available for optimum growth and productivity, but there will never be excessive amounts that could leach or run off causing adverse impacts on the environment.

At the same time, the increase in productivity and the progressive increase in soil organic matter, results in the accelerated removal of carbon dioxide from the atmosphere, aiding in the control of global climate change. Also, **as the condition and function of the soil improves, the amount of fertiliser required each season decrease**s until only small maintenance applications are required.

Biological Activity

With a good physical environment and good nutrient fertility, the biological activity in the soil will also improve. However, soil organisms are highly sensitive to disturbances such as cultivation and fertiliser application. To help minimise the impact of these disturbances, and maintain the benefits of a biologically active soil, appropriate applications of various bio-active materials are advisable. Research has shown how to determine which materials, and at what rates these applications should be made.

In our world, where the population continues to grow, yet the area available for agriculture, at best, remains the same, this philosophy becomes ever more important if we are to continue producing both the quantity and quality of food required by the people of the world.

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Below. *The author at work at SWEP Pty Ltd.*

Introduction

From the introduction of agriculture into Australia after colonisation, substantial differences have been found between Australian soils and those elsewhere, particularly those in the northern hemisphere.

Significant factors contributing to these differences include the Calcium to Magnesium Ratios. Indicated by the author's original work (1968), it was found that soils high in magnesium set hard when dry, but when wet, often behave much like sodic (high in sodium) soils.

According to his research, Australian soils tend to be higher in magnesium compared with other soils in the world. This is why the threshold for sodicity in Australia is 5% exchangeable sodium, and in North America it is 15%. The higher magnesium means soils in Australia need less sodium than Northern American soils before showing symptoms of sodicity.

Another difference stems from the age of Australian soils. Even from the beginning of colonisation, problems of sustainability were experienced. None of the European plants, livestock or farming methods introduced by the First Fleet would work here. Consequently, colonists faced a dire situation and near starvation until their salvation at the arrival of the second fleet.

Over the millennia, Australian soils have become progressively impoverished, not only regarding phosphorus but also as cations have been lost and replaced by hydrogen.

In North America, a common practice for estimating hydrogen has been to use the pH of the soil and the amount of base cations as a guide. This may work well enough in the generally younger soils of that region, but in the older soils of Australia, this practice is unsuitable because it leads to a significant underestimation.

In 1966, the development of testing for exchangeable hydrogen provided a significant advance in soil science. When this testing was made available in Australia in 1968, the author subsequently used it in all his research to avoid the inherent inaccuracies when estimating hydrogen.

Other distinctive features of Australian soils, including aspects relating to organic matter, soil biology, and a number of trace element deficiencies, were only discovered as farmers experienced strange new problems uncommon in many other parts of the world.

It has taken a long time indeed for us to learn how to farm this country. In fact, we are still learning. As recently as the 1960s and 1970s, many farmers believed that the only way to increase productivity was to buy the neighbour's property and so increase their scale of production (horizontal integration).

The real lesson from the Australian agricultural experience is that when something seems to work well enough on soils in one region or country, it should not be simply transplanted to other places and be expected to provide the same results.

Rather than simply chasing an endless chain of response-correlated field trials, we must develop a proper understanding of how soil functions, and use this knowledge as our basis for developing appropriate and sustainable (vertically integrated) farming systems. In short, we must begin with the most basic question of all… **what is soil?**

What is Soil?

Soil is ultimately the source of all life. We recognise this in the way we speak of ourselves as coming from and returning to the soil, *"for dust thou art and unto dust shalt thou return"*. Yet, in the traditional sense, soil may be described simply as a medium for plant growth – the roots of a plant grow in soil, and through them plants obtain water and most of the nutrients necessary for growth. While this is true, it is a gross oversimplification.

Soil also provides anchorage and physical support for the plant, and an environment which must be suitable for the needs of the plant as well as the needs of a community of other inter-dependent organisms. Considering these facts, it would seem only logical to regard soil not as just a medium for growing plants, but as ***a living system where healthy soil is alive through the presence of microbial life, being strongly friable and nutritionally well balanced***.

In this sense, soil may be best considered as having three inter-related, and mutually supportive components:

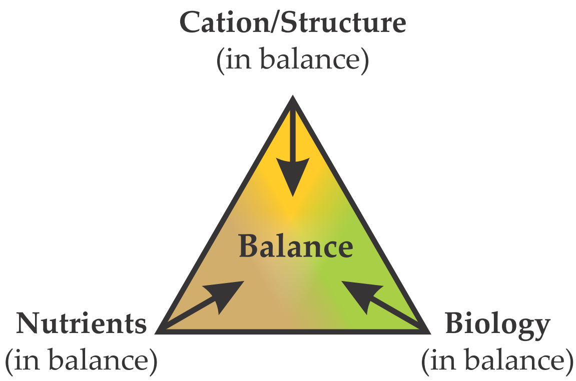
- **Soil Physics** ("structure" e.g., friability, aggregate stability, etc.),
- **Soil Chemistry** (nutrients),
- **Soil Biology** (microbes).

These components should be in balance individually, and in balance with each other as shown in the diagram below *(Figure 1)*.

In the first instance, the major factors affecting soil management will be Land Use and the Cation Exchange Capacity (CEC). However, there is often confusion regarding CEC.

The major cations (positively charged chemicals such as magnesium, calcium, potassium, and sodium) that contribute to the CEC are also plant nutrients. Early soil research viewed cations only in nutrient terms. What they didn't understand was how cations function with the other aspects of the soil to enable the plant to take up the nutrients. They believed that having the nutrients in the soil was all the plant needed. But this did not account for how plants can be deficient in nutrients that are present in the soil.

Figure 1*. Schematic representation of the components and inter-relationships described by the Mikhail System.*



Unfortunately, still today many people speak in simple terms of nutrient deficiency and excess. For example, many researchers still claim that the ratio of calcium to magnesium (Ca:Mg) has no effect on plant growth, insisting that there is no difference in yield regardless of the ratio. They fail to identify nutritional deficiencies within the plants they are growing in trials – deficiencies which can be addressed by adjusting Ca:Mg. Also, trial work done under ideal conditions fails to measure differences under less than ideal conditions, e.g., moisture stress, low nitrogen, or trace element deficiencies.

They don't understand that even though there may be no direct effect on plant yield, the impact of Ca:Mg on the physical character of the soil (as we will see later) can significantly affect plant growth and quality. In fact, from his research in 1968 on Australian soils, the author was the first to demonstrate the effect of the calcium and magnesium ratio.

So it is here that our discussion begins, not with nutrition but with soil physics which is the essential first step for soil improvement.

As you proceed through this book be sure to keep these basic principles clearly in mind as they are key to proper understanding of soil function. Here they are again:

- **Soil is a living system** where healthy soil is alive through the presence of microbial life, being strongly friable and nutritionally well balanced.
- **Soil has three inter-related and mutually supportive components**: Soil Physics ("structure" e.g., friability, aggregate stability, etc.), Soil Chemistry (nutrients) and Soil Microbiology.
- **Each of these components should be in balance** individually, and in balance with each other.
- **The proper place to begin improving the soil is in optimising its physical environment**, NOT simply adding nutrients and fertiliser!