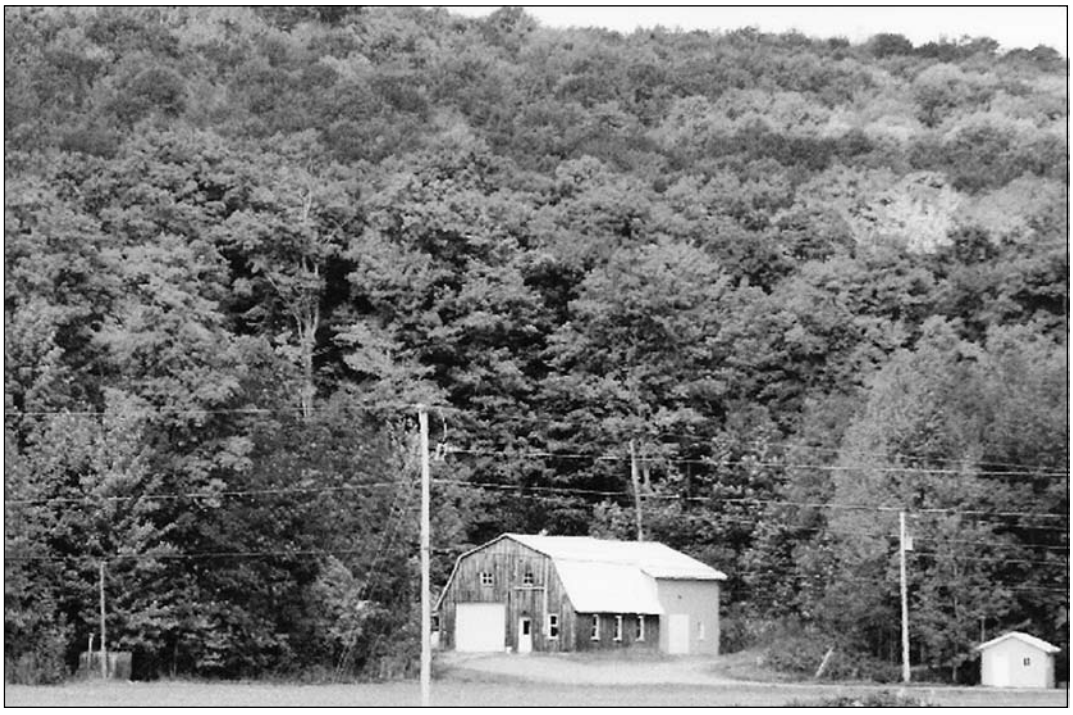

Quebec's Tranquility Farms, where owner Truman Clark discovered that amending his soil with beneficial microbes not only improved tilth and allowed his maple trees better access to soil nutrients, it also allowed them to better withstand harsh northern weather that severely damaged neighboring stands.

Minimizing Environmental STRESS

by Athena Tainio & Bruce Tainio

Icy rain began to fall from a gray January sky and drip from the bare branches of dormant sugar bush on Tranquility Farms. The sleeping trees were not due to awaken until early spring, when the combination of warm sunny days and sub-freezing nights would signal their hydraulic systems to begin the flowing of sap through their tissues. Miles of plastic tubing would carry the thin liquid from the maple trees to the farm's *cabane à sucre* (sugar shack), as it is called in Quebec, to be condensed by evaporation into the sweet amber syrup that pancakes are smothered in at breakfast tables around the world.

The freezing rain fell steadily, forming icicles on the branches of the trees and the eves of buildings, draping Tranquility Farms and much of southeastern Canada in a ghostly crystal shroud. As the freezing rain continued to fall, everything became coated in thick, crushing sheets of ice. It was just after New Year 1998, and the ice storm of the century had hit eastern Canada and the northwestern United States. The storm would continue for six days, accumulating up to 3 inches of ice in some areas. Power lines collapsed under the heavy weight, cutting off power to up to 4.7 million people. Tree limbs broke, smashing cars and rooftops and blocking roads. Schools and businesses closed, and commerce came to a halt.

In Quebec, which produces about 75 percent of the world's production of maple sugar, the sickening crack of snapping tree branches echoed through the forests, resulting in devastating damage, both of trees and tubing, from which it would take many years for the maple sugar industry to fully recover. Aerial surveys would later show that 10 million hectares (almost 25 million acres) of Canadian woodlands were affected by Ice Storm '98.

Not so much on Tranquility Farms, though. Owner Truman Clark had been studying soil biology, and in the previous year had amended the soil around his maple trees with diverse populations of beneficial microbes. The soil in his region is typically heavy clay, a difficult form for trees to extract minerals from. His goal was to improve the tilth of his woodland soil, which would give the maple trees better access to nutrients.

Microbes build soil by breaking down organic debris. They create air spaces that provide increased oxygenation to root systems and transform minerals into available forms that plants and trees can use. With adequate mineral uptake, the maple trees of Tranquility Farms were better equipped to withstand the rigors of harsh northern conditions.

POTASSIUM POWER

By studying potassium-deficient wheat, we see evidence of nutritional influence on plant vigor in the form of lodging. When heavy rain or hail comes along, the weakened stalks can't hold up under the heavy weight of the full seed heads. We know that potassium has the ability to triple the strength of cell wall structure, so when adequate potassium is available to the plant, the cell walls of the wheat stalks are strong enough to hold up under environmental stress and heavy load.

Potassium also acts as a natural antifreeze to trees and plants, providing the plant with the mechanism to produce enzymes, which break down proteins into sugars. Sugars provide a source of energy to help the plant withstand lower temperatures. Frost damage can be avoided or minimized by a foliar application of potassium a few hours before an anticipated freeze. This same energy release also plays an important role in recovery in cases where plants and trees do become damaged by weather, disease or insect attack.

The increased availability of nutrients mined from the soil by microbes gave the maple trees of Tranquility Farms the nutritional support they needed for strength and resilience in the face of disaster. After the ice storm was over, Truman Clark found his stand of maple trees had suffered little damage in contrast to his surrounding neighbors and beyond, where miles of devastation lay in the wake of the storm.

> "The wind will not break a tree that bends."
>
> — *African proverb*

On a side note of concern, the maple sugar industry in New England and Vermont is reportedly being gradually forced further north into Canada's colder climate zone. The trees require just the right combination of warm days and sub-freezing spring nights to cause hydraulic action to make their sap run, and in fact, the maple sugar industry in the United States appears to be declining as the climate zones change and we lose this short window of necessary weather conditions.

Truman Clark reports that by applying potassium sulfate to his trees, the leaves open earlier and stay green in the fall longer than those that have not been treated.

Although we could not find reference to any studies on the effects of nutrition on the flow of tree sap, it does give us food for thought.

SOUTHERN DROUGHT

Whether from global warming or overdevelopment, the periodic water shortages in California cause another set of environmental stresses of equally serious consequence. Understanding soil biology can reduce much loss caused by drought. Simply put, microbes make air spaces for capillary action, and so decreased microbiology leads to compacted soil and decreased water absorption.

Although the similarities between an almond orchard in Central California and a stand of native maple trees in southeastern Canada aren't immediately evident, the trees' requirements for good soil biology and balanced nutrition for withstanding environmental challenges are just as important.

Unlike the wild woodlands of Quebec, the almond orchard consists of perfectly straight rows of uniformly pruned trees that remind one of lines of soldiers in formation. The corridors between the rows look like roads, meticulously maintained for ease of harvesting and maneuvering of spray equipment, and in some cases, they also double as flood irrigation channels. These corridors are commonly sprayed with herbicides and graded to keep the surface smooth for easier harvesting.

Whenever humans manipulate or interfere with nature, we risk creating environmental conditions that adversely affect the density and composition of fragile soil bacteria populations. Moisture, aeration, temperature, organic matter, pH, chemical use, fertility programs — all impact soil biology.

While visiting some almond orchards in California, we had arrived at one particular farm in time to watch as a section of trees were being watered by flood irrigation. In this method, water is routed (or pushed) between the rows, where it is supposed to percolate into the soil. The farmer pointed out a nearby section of trees that had been irrigated several days prior, but the water was still

standing nearly as deep as the newly irrigated section. Even though the trees were standing in water, their leaves were wilted and beginning to yellow as if they were dehydrated. It was evident that this farm had severely compacted soil, and the water was not able to reach the roots of the thirsty trees. Each section of trees needed to be watered every seven days, but very little of the water could penetrate through the hardpan, most of it evaporating in the hot, hundred-degree temperatures. Probing indicated the presence of moisture only within the top 3 inches of soil.

To loosen the compacted soil, microbes and enzymes were applied through the irrigation water to a 40-acre section, and within just two or three days, the microbes made it possible for all of the water to be absorbed into the soil. When probed, moisture was found as deep as 30 inches.

Once all of the rows were treated with microbes and enzymes, the farmer was able to reduce the watering cycle from every seven days to every 13 days. The soil became increasingly more porous as the microbes did their work, and the water at the beginning third of the row was now being absorbed into the soil before the flow reached the far end. No more standing water to evaporate away, the trees were getting plenty of water, and the farmer saved money on irrigation costs.

MINERAL MAGIC

A common practice in California and other areas where high-alkaline soils are prevalent is to use sulfur to bring the pH down. But sulfur tends to overheat the soil, which in hot, dry climates means faster evaporation and higher water requirements. Alternatively, calcium sulfate can be used to lower the pH without heating the soil.

Potassium helps plants conserve water by regulating the fluid pressure in a plant's guard cells. In apple orchard studies, we found that potassium deficient trees showed a greater loss of water than the trees with adequate levels.

Granny Smith apples, which are particularly susceptible to sunburn, supported with potassium and trace elements became less susceptible to sunburn damage.

Dryland farmers who rely exclusively on precipitation for moisture often mistake the symptoms of nitrogen overload for drought damage. Nitrogen forms proteins, which in large amounts and under conditions of little water, can clog up the plant's vascular system and putrefy in the leaf tissue, which causes symptoms that resemble drought stress.

Spoon-feeding the plants with nitrogen throughout the growing season while adjusting the amounts according to the amount of available moisture helps produce more drought-tolerant plants and guards against nitrogen burn.

21ST CENTURY ENVIRONMENTAL STRESS: EMF

For a number of years we have been encountering a phenomenon where, no matter how well we balance the nutrients and the microbiology of the soil in certain fields, the plants still suffer from mineral deficiencies, calcium in particular.

Scientific studies have determined that electromagnetic frequencies (EMFs) at certain voltages can pull calcium ions from cell membranes (see Andrew Goldsworthy, "The Cell Phone and the Cell: the Role of Calcium," available online at *www.scribd.com/doc/7636830/The-Cell-Phone-and-the-Cell-the-Role-of-Calcium*) This may be a clue to the mystery we have seen in the field.

Even before we had become aware of these studies, we were able to successfully ease EMF stress on trees that were dying along either side of a swath of power lines that ran through the middle of a forest. By installing a device to protect the trees from these harmful chaotic frequencies, the trees in the forest soon returned to their normal healthy state.

We did a similar project in an apple orchard where the trees would only live about five years before the trunks would unexplainably begin to split open, and the trees would die. The apple trees were trellised on wire, and growing near a high-voltage power transfer station. The trellis wires were conducting static electricity from the power lines to the trees, so strongly that the farm workers didn't like to work in that section because of the shocks they would receive when they touched the trellis wire. By installing the same type of unit used in the forest project, EMF pressure was relieved and the apple trees were once again healthy, and have been for a number of years.

When we learned of the studies that had been done on EMF effects on calcium in living cells, we set out to conduct some experiments. In certain areas where calcium uptake in plants was historically problematic, we installed the solar-powered EMF protection device, and although further studies are needed, preliminary findings have been encouraging. In tomatoes we increased calcium uptake by 70 percent without the addition of fertilizers, and in alfalfa we saw an 83 percent increase. In addition, we saw significant improvement in uptake of other minerals as well.

TECHNOLOGY & NATURE: FINDING BALANCE

The rapid advancement of technology in the past few decades has launched mankind into deep, uncharted waters. Electromagnetic frequencies from communications systems, which studies confirm are disruptive to cells, now blanket the earth. Biotechnology races to create super plants that can withstand the wrath of nature, and yet little is known of the long-term effects these modifications will have on our environment and our health.

Experts flocked to Tranquility Farms the year of Ice Storm '98, seeking the holy grail that was responsible for saving its resilient trees from destruction, but many came away disappointed, convinced there had to be more to the story than Truman Clark's simple good soil biology practices.

Just as the wind will not break a tree that bends, by understanding and working with nature rather than attempting to outsmart her, many potential environmental crop disasters can be minimized. We can do this by practicing balanced, sustainable farming.

Bruce and Athena (Teena) Tainio are President and Vice President of Tainio Technology & Technique, Inc., a manufacturer of biological products in Cheney, Washington. They can be reached at 509-747-5471. For more information you can visit their website at *www.tainio.com*.