

The SumaGrow Solution for Sustainable Agriculture



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I. INTRODUCTION

Planet Earth is facing many challenges when it comes to agriculture and the world's food supply. The world needs more food and more nutritious food, grown without reliance on unsustainable inputs, at a reasonable cost, without further damaging the environment.

To some, a solution seems highly improbable.

Others see the need for more new technologies which will fundamentally change our food supply – Genetically Modified (GM) crops, “petri-dish” meats, heavier reliance and greater adoption of fertilizer and pesticides regimes in lesser developed countries, or even urban farming.

This paper will not address these technologies or ideas; however, as Bio Soil Enhancers, Inc. (BSEI) believes sometimes a step backwards is progress. BSEI believes significant improvements – higher yield, dramatically reduced inputs and alleviation of environmental damage – can be made to existing farms and farming methods with the use of its award winning products containing *SumaGrow™*.

BSEI products containing *SumaGrow™* can increase crop yields, reduce or eliminate fertilizer, and allow crops to grow with reduced water and pesticide usage. Additional benefits include higher nutrient levels in the crops, bio remediation of the water and soil, and perhaps most importantly, greater profits to farmers.

BSEI realizes the benefits sound “too good to be true,” however; there is ample documentation from credible third parties to attest to the veracity of these benefit claims. *SumaGrow™* products have been successfully used throughout the United States and in over 40 countries around the world. Perhaps most importantly, almost all end users who have used the product continue to re-order.

SumaGrow™ benefits solve a number of pressing problems pertaining to agriculture:

- Increase food production to feed a growing population
- Decrease food production costs by increasing revenues (yield) and decreasing costs (inputs such as fertilizer, water and pesticides)
- Increase nutrition levels by growing healthier crops
- Increase shelf life of crops due to higher brix levels
- Bio remediate the soil – BSEI products will “eat” residual fertilizer salts, pesticides and other toxins in the soil
- Bio remediate the water – via a dramatic reduction in water runoff, and a reduction of the nitrates and phosphates in the water
- Climate change alleviation – via a reduction in petrochemical based fertilizers and pesticides; higher yield of existing land reduces the need for deforestation of land for additional crop or grazing land; carbon sequestration in the soil

In production terms, sustainable agriculture refers to the ability of a farm to continue producing indefinitely, with a minimum of outside inputs.

In environmental terms, sustainable agriculture should not have to rely on natural resources which have a finite supply. Agriculture that is very inefficient - low on the sustainability scale - will eventually run out of resources, or the ability to afford scarce resources, and cease to be viable.

In an economic context, sustainable agriculture must generate profits for producers to acquire things which cannot be produced directly. The larger the profits generated from new technologies, the faster the implementation.

While there are many serious issues which need to be addressed concerning sustainable agriculture and the world's food supply, this white paper will detail the benefits of products containing **SumaGrowtm** to combat all of the issues listed here. For ease of understanding, the benefits will be grouped into the following categories – cost effective yield increase, nutrient level increases, reduction in fertilizer, increase in water efficiency, reduction in pesticides usage and ability of crops to better withstand stresses.

II. The SumaGrow Solution

“Don’t be afraid to take a big step when one is indicated. You can’t cross a chasm in two small steps.”

David Lloyd George

COST EFFECTIVE YIELD INCREASES

By far the most significant benefit of products containing **SumaGrow™** is the yield increase. It is only half-joking to state yield increase is numbers one through nine on the Top 10 list of benefits.

Based on usage on a variety of crops, in multiple types of soil and weather, in the U.S. and over 40 countries around the world, ***a yield increase of 10-20+% can be expected compared to the grower standard, 100% petrochemical based fertilizer system***, or compared to various other growing protocols such as organic fertilizers, raw milk or fish products.

The yield increases are achieved cost effectively as products containing **SumaGrow™** cost less than fertilizers and pesticides they replace in almost all cases, with the yield increase as a no-added-cost benefit. Even in countries where fertilizer is subsidized, producers will increase their bottom line profits when using products containing **SumaGrow™**.

Moreover, these results have been documented by credible third parties, such as universities (both U.S. and international), independent PhD’s and testing companies, farmer co-op’s and government agencies.

The following is a representative sampling of results:

Alfalfa – Michigan State University – One gallon and 1.5 gallons of a product containing SumaGrow were compared to a control field resulting in yield increases of 29% and 33%, and a profit advantage of \$58 and \$62 per acre.

Bananas – The Dominican Institute of Agriculture and Forestry Research (IDIAF) found the nitric perchloric digestion went from 0.13 in August to 2.77 in November, as measured by AA Spectrophotometer reading in flame. “The nitrogen has a positive influence on the output, the amount yielded per cluster, and the length of the fruit. There is a positive response with the optimal nitrogen levels (N) and this helps reduce the incidence and severity of SIGATOKA.”

Cabbage – Rutgers University – head size increased 23% and brix levels increased by 14%

Cattle Weight Gain – Murray State University (Kentucky) – cattle gain of 40.5 extra pounds during a 150 day grazing season; higher compared to grower standard fertilized pastures; also higher Animal Unit Months (AUM) and Return on Investment (ROI)

Cotton -- Jiangxi Agricultural University, China – Cotton yield increase 23%, lint yield increase 28%

Corn – Arise Research & Discovery, Illinois – corn yield increased 19%, with a 50% reduction in fertilizer, compared to grower standard of 100% fertilizer

Forage Grass – Telus Consulting, Virginia – higher yield (36%), more nutrients (crude protein and digestible protein), improved soil (higher calcium, phosphorous, potassium and magnesium), greater weight gain (extra 2/10 of a pound per day) and lower cost than grower standard fertilized fields

Golf Courses – Turfgrass Disease Solutions, Pennsylvania – golf course turf was comparable in quality and color using ReeCourse Golf (SumaGrow inside) and 20% fertilizer (80% reduction) compared to 100% fertilizer, and color was better with solely ReeCourse

Green Peppers – Holden Research, California – increased the net profit by over \$4500 per acre when reducing fertilizer by 75%

Pumpkins – Earth and Plant Sciences, New Mexico – increased the net profit by over \$3400 per acre

Rice – U.S. Department of Agriculture, Beaumont, Texas – in a preliminary border test, achieved a yield increase of 30% without using any other fertilizer

Soybeans – Arise Research & Discovery, Illinois – soybean yield increased 27%, with a 50% reduction in fertilizer, compared to grower standard of 100% fertilizer

Soybeans – Illinois Soybean Association Yield Challenge – won first place in District 9 (only district entered); Monsanto came in second

Strawberries – Holden Research, California – increased the net profit by \$1185 per acre with a 20% reduction in fertilizer compared to grower standard

Sugar Cane -- Shree Khedut Sahakari Khand Udyog Mandli, (farmer's co-op) India – 16% higher yield with zero fertilizer compared to grower standard; higher brix and higher quality juice

Tea – Nanjing Forestry University, China – “... all parameters related to plant growth vigor increased by more than 25% as compared with those of untreated tea trees” and the product “produces positive effect on the soil.”

Tomatoes – Mississippi State University – increased the yield of tomatoes by 15% compared to grower standard while reducing fertilizer by 50%

A typical treatment would be one gallon of a **SumaGrowtm** product per acre, 1.5 gallons per acre if the soil is either very sandy or has extreme amounts of clay, and two gallons per acre for organic production where no other fertilizer is used. The products costs vary based on container size, quantity, shipping cost and import duties, but generally \$75 per gallon or less.

With this amount of product at this cost, the Return on Investment can truly be outstanding. What producer would not spend \$75 per acre to increase their profits by \$1185/acre in strawberries, \$3400/acre in pumpkins or \$4500 in green peppers? Even with large scale, traditional row crops such as corn or soybeans, the ROI can easily be several hundred percent in a matter of a single growing season.

NUTRIENT LEVEL INCREASE

Products containing *SumaGrow™* have been documented to increase protein levels, chlorophyll (a good indicator of plant nutrients) and brix levels. While it is more accurate to state products containing *SumaGrow™ balance* the nutrient levels, since most soils are deficient in nutrients, before and after testing typically shows nutrient level increases.

There are numerous benefits to higher nutrient levels in our crops. The first benefit which should come to mind is better health. More nutrients per grain of rice should lead to healthier humans who should be less susceptible to disease. This is especially important in less developed countries where access to alternative sources of nutrition, such as vitamin supplements, is limited.

Higher brix levels (predominantly natural sugars) typically correspond to higher nutrient levels. Higher brix levels have better taste which encourages greater consumption of healthier foods. This leads to higher weight gain in cattle.

Higher brix levels cause greater nutrient absorption in the body. Due to the combination of higher nutrients and greater absorption, a high brix peach has *five times* the nutrient value of a low brix peach.

Foods with higher brix levels have longer shelf lives, leading to less spoilage, again, especially beneficial to less developed countries where food distribution systems are not adequate to get crops to market in a timely manner.

Higher brix levels also lead to fewer plant diseases and insect problems (see Pesticide Reduction for more information).

Several of the studies referenced in the Cost Effective Yield Increase section address the higher nutrient levels as well – the higher nitrogen levels in bananas are an indicator of higher protein, higher brix levels were specifically mentioned in the cabbage and sugar cane trials cited above, and the forage grass study documented both the total crude protein and the digestible protein.

Below are some additional studies concerning nutrient level increases:

Michigan State University

Testing was performed by Michigan State University which measured the chlorophyll changes (as well as yield) in a variety of crops. The testing compared 50% fertilizer with the addition of *SumaGrow™* product (T1) to 50% fertilizer only (T2) and to *SumaGrow™* product alone (T3).

F2 (see the key to the chart) is *SumaGrow™* product which, when used alone (T3), is the clear winner in chlorophyll content (and yield). More importantly, T3 (*SumaGrow™* product alone) obtained higher chlorophyll levels (and yields) than *SumaGrow™* product with 50% fertilizer (T1), which did better than fertilizer only (T2); Please note, as the amount of fertilizer was reduced, the chlorophyll levels (quality) went up.

	Plant height(inches)			Chlorophyll content			Total yield(g)		
CROP	T1	T2	T3	T1	T2	T3	T1	T2	T3
CORN	90*	56.3	96.25*	40.3	33.8	47.4	384.9*	119	563*
SOYBEAN	38	40	42	42	40	47	71.2*	44.4	71*
GARDEN BEAN	83.3*	54.5	104*	39.6	35.2	46.13	299*	192.8	504.5*
TOMATO	31.5	31.2	42	42	34	47	400*	140	720*
CLOVER	23.2	18	23.7	43.1	37.3	46.7	133*	107	159*
MEAN OF 4 REPLICATIONS * significant, P = 0.022 Clover=Shoot biomass T1 → F2 with NPK 50% (20-20-20) T2 → NPK 50% (20-20-20)50% © T3 → F2 ONLY									

Tecomate (Barenbrug) Food Plots

Tecomate is a U.S. subsidiary of Barenbrug. Tecomate specializes in seed mixtures for hunters' food plots and Barenbrug is an international seed (primarily grass) company headquartered in the Netherlands.

Two different hunter food plot seed mixtures (Tecomate Monster Mix and Tecomate Max-Attract 50/50) were tested to determine the protein percentage (and yield). If we look at just the first two test points – 300 pounds per acre of triple 13 NPK fertilizer (a typical full fertilizer treatment) versus 300 pounds *and the addition of one gallon per acre of SumaGrow™ product*, it shows the yield actually decreasing, although, protein levels still went up with the addition of SumaGrow™ product.

Tecomate Monster Mix

Plot Number	Fertilizer Rate per Acre (lbs)	SumaGrow™ Rate per Acre (gallons)	Yield in Volume (lbs)	Protein Result (%)
1	300	0	8.75	0.001
2	300	1	8.5	0.42

Tecomate Max-Attract 50/50

Plot Number	Fertilizer Rate per Acre (lbs)	SumaGrow™ Rate per Acre (gallons)	Yield in Volume (lbs)	Protein Result (%)
1	300	0	8.75	3.95
2	300	1	7	4.09

When the traditional fertilizer treatment is reduced to 200 pounds per acre, then 100 pounds per acre and finally with zero fertilizer, and *SumaGrow™ product* is added at the rate of one gallon per acre protein levels rise even more as the fertilizer is reduced.

Tecomate Monster Mix

Plot Number	Fertilizer Rate per Acre (lbs)	<i>SumaGrowtm</i> Rate per Acre (gallons)	Yield in Volume (lbs)	Protein Result (%)
1	300	0	8.75	0.001
2	300	1	8.50	0.42
3	200	1	9.75	0.50
4	100	1	8.50	0.87
5	0	1	8.25	2.33

Tecomate Max-Attract 50/50

Plot Number	Fertilizer Rate per Acre (lbs)	<i>SumaGrowtm</i> Rate per Acre (gallons)	Yield in Volume (lbs)	Protein Result (%)
1	300	0	8.75	3.95
2	300	1	7.00	4.09
3	200	1	8.50	4.36
4	100	1	9.25	4.56
5	0	1	8.75	4.44

Please note, the highest yields were obtained with either a 1/3 or 2/3 reduction in conventional fertilizer.

It is worth noting these Tecomate food plot tests were conducted in 2007 using an earlier version of *SumaGrowtm* product, which has since been improved, hence, additional fertilizer reductions may currently increase the yield further.



Tecomate Max Attract 50/50 with 13/13/13 Fertilizer



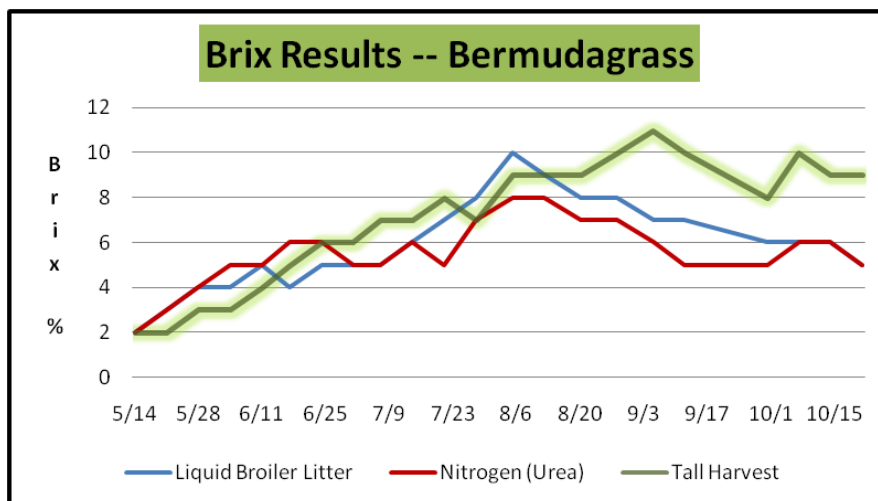
Tecomate Max Attract 50/50 with *SumaGrowtm* (no fertilizer)

Tallgrass Beef Company

Tallgrass, a premier marketing company of grass fed beef in the U.S., conducted a five month field trial at the LHOP Ranch in Independence, Kansas, on two 100 acre plots which were each split into three roughly equal sized pastures. A *SumaGrowtm* product treated pasture was compared to two control pastures; one treated with nitrogen only (urea) and the other treated with an organic, liquid

broiler litter (LBL). Group 1 (Pastures 1, 2, 3) Treatment pasture grasses consisted of Kentucky 31 Fescue interseeded with Brassicas, Chicory, and White Clover.

In addition to yield increase, the study also included weekly brix levels measurements. The *SumaGrow™* product treated pastures handily beat both the urea and organic LBL treated pastures by producing significantly higher brix levels.



The more conventional fertilizers are reduced, all the way to zero fertilizer, the higher the *quality* of the crop using a *SumaGrow™* product; in the testing shown above, this would specifically include higher protein content, higher chlorophyll levels and higher brix levels.

SumaGrow™ microbes are “carried” in a base of liquid humates (humates consist of organic matter which didn’t quite make it to coal). Micronutrients found in humates, such as calcium, magnesium, zinc, iron and manganese, among others are very important in the development and growth of plants (and humans). They are needed in small quantities, but are necessary for plant health, growth, metabolism and synthesis.

Impact of micronutrient deficiency in crop production is most commonly measured as loss of crop yield. However, for a range of crops, effects of micronutrients on crop quality such as oil, protein or fiber content, absence of defects, and storage longevity are important for the price of agricultural products in markets. In other cases, low symbiotic nitrogen (N) fixation by legumes is the main impact of micronutrients in cropping systems. Low micronutrient levels in seed for planting are having large unrecognized impacts on the costs of crop production and low levels in consumed foods are contributing to the high global levels of micronutrient deficiencies in humans.

The benefit most producers seek from using micronutrient fertilizers is an increase in income due to increased yield or quality of harvested products, however, in the most severely deficient soils, the application of micronutrient fertilizer makes an absolute difference between being able to use land productively for agriculture, or not.

FERTILIZER REDUCTION

SumaGrow™ products are known to dramatically increase yields. The data shows a significant reduction, even elimination of fertilizer, is necessary to obtain these yield increases. While it may seem counterintuitive to reduce fertilizer usage to increase yields, the data speaks for itself. In fact, if fertilizer is not reduced when using *SumaGrow™* product, there is even a chance the crop yields will be reduced, not increased.

In layman's terms, if 300 pounds per acre of NPK (Nitrogen, Phosphorous and Potassium) were the norm and you added an additional 300 pounds, the yield would likely go down; you might even severely damage the crop (like fertilizer burn in a lawn). If we use the assumption *SumaGrow™* products by themselves, similar to the way Mother Nature works, are sufficient to provide adequate fertilization to most crops, then the addition of 300 pounds of NPK (the regular treatment), will likely harm the yield. Maybe not as severely as the normal 300 pounds of fertilizer plus an additional 300 pounds of fertilizer, but 300 pounds of fertilizer in addition to *SumaGrow™* products seems to cause a problem of not increasing, or even reducing, the yield.

In more technical terms, excess nitrogen causes excessive vegetative growth resulting in a high shoot/root ratio, delayed onset of flowering and low harvest index in agricultural crops. Plants with excess nitrogen are dark green in color with succulent leaves and susceptible to water stress and diseases. Due to excess nitrogen, plants fail to flower and yield. An excessive amount of nitrogen in ammonium form in the soil can interfere with calcium uptake by the plant leading to problems such as blossom-end rot in tomatoes and tip burn in lettuce. Similarly, excessive nitrates will interfere with potassium uptake by the plant leading to poor flower and fruit set.

There are several controlled studies which have been performed which show the negative effects of full fertilizer and the addition of *SumaGrow™* products.

Michigan State University

When previously shown in the Nutrient Level Increase section, the Michigan State University studies documented the chlorophyll levels. We will now look at the yield response to reduced fertilizer. The testing compared 50% fertilizer with the addition of *SumaGrow™* product (T1) to 50% fertilizer only (T2) and to *SumaGrow™* product alone (T3).

F2 (see the key to the chart) is *SumaGrow™* product which, when used alone (T3), is the clear winner in yield with the exception of soybeans which is essentially a statistical tie with *SumaGrow™* product and 50% fertilizer (T1). More importantly, T3 (*SumaGrow™* product alone) obtained higher yields than *SumaGrow™* product with 50% fertilizer (T1), which did better than fertilizer only (T2); as fertilizer was reduced, the yield went up, except for soybeans which was a statistical tie.

CROP	Plant height(inches)			Chlorophyll content			Total yield(g)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
CORN	90*	56.3	96.25*	40.3	33.8	47.4	384.9*	119	563*
SOYBEAN	38	40	42	42	40	47	71.2*	44.4	71*
GARDEN BEAN	83.3*	54.5	104*	39.6	35.2	46.13	299*	192.8	504.5*
TOMATO	31.5	31.2	42	42	34	47	400*	140	720*
CLOVER	23.2	18	23.7	43.1	37.3	46.7	133*	107	159*
MEAN OF 4 REPLICATIONS * significant, P = 0.022 Clover=shoot biomass T1 -> F2 with NPK 50% (20-20-20) T2 -> NPK 50% (20-20-20)50% © T3 -> F2 ONLY									

Mississippi State University

The table below shows the response of cilantro shoot yields comparing 50% conventional fertilizer (½ X) and 100% conventional (1X) fertilizer rates (grower standard), with the addition to both of a *SumaGrow™* product (Yes) application at the equivalent rate of one gallon per acre, tested at Crystal Springs, MS.

The addition of *SumaGrow™* product to the full fertilizer treatment showed an increase of only 7.5% (2.58 vs. 2.40) in yield while the addition of *SumaGrow™* product to the ½ fertilizer treatment showed an increase in yield of 19.2% (2.98 vs. 2.50); as fertilizer was reduced the yield went up.

Treatment	Fertilizer Rate	SumaGrow Product	Total Weight
1	½ X	No	2.50
2	½ X	Yes	2.98
3	1 X	No	2.40
4	1 X	Yes	2.58

In tomatoes, the results were even more striking, as the tomato yield with 100% fertilizer and *SumaGrow™* product was actually lower than the yield with just 100% fertilizer.

The addition of *SumaGrow™* product to the full fertilizer treatment showed a *decrease* of 1.9% (72.7 vs. 71.3) in weight while the addition of *SumaGrow™* product to the ½ fertilizer treatment showed an increase in yield of 15.1% (83.0 vs. 72.1); as fertilizer was reduced the yield went up.

The table below shows the total number and weight of tomatoes comparing 50% conventional (½ X) and 100% conventional (1X) nitrogen fertilizer rates (grower standard), with the addition to both of a *SumaGrow™* product (Yes) application at the equivalent rate of one gallon per acre.

Treatment	Fertilizer Rate	SumaGrow Product	Total No.	Total Weight
1	½ X	No	147.0	72.1
2	½ X	Yes	158.5	83.0
3	1 X	No	156.0	72.7
4	1 X	Yes	150.3	71.3

Many crops are grown under conditions which Mother Nature never intended, such as thousands of acres of a monoculture crop, e.g., corn or wheat. As this method of growing puts tremendous stress on the soil, some fertilizer is needed.

There are other crops, however, where the stress on the soil is not as significant, where fertilizer can be reduced even more than 50%. In many grass/turf applications – forage grass, grass hay and ornamental turf (including specialty applications such as golf courses) – fertilizer rates have been reduced 80-100% for tens of thousands of applications, almost always with better results than 100% fertilizer.

Additionally, organic growers use products containing *SumaGrowtm*, as well as end users in many foreign countries, without the addition of any petrochemical fertilizers. Notably, this includes China and India where hundreds of field trials has been performed without fertilizer and achieved significantly positive results. In India alone in 2012, over 400 field trials were performed.

Fertilizer reduction has a positive impact on the environment. While it should seem fairly intuitive cutting fertilizer 50% reduces fertilizer runoff by 50%, when using products containing *SumaGrowtm*, it is actually better than assumed.

Testing performed at the Arise Research & Discovery testing facility in southern Illinois was conducted to measure nitrate run off. Arise has constructed specialized containment bays where the soil was dug up 42 inches deep and a plastic liner inserted on the bottom and sides, along with a piping system. The soil was replaced and corn grown in the soil of the containment bay.

When adding a product containing *SumaGrowtm* to the conventionally fertilized soil, at both 50% and 100% fertilization rates, the amount of water running off was reduced by roughly 50% as the *SumaGrowtm* product increases the water holding capacity of the soil. Additionally, the nitrates in the water were also measured and were reduced by approximately 40%, measured on a percentage basis. Combining the water runoff reduction with the nitrate reduction achieved a total nitrate run off reduction of approximately 70%.

Nitrogen fixing bacteria, which transfer nitrogen compounds into a form plants can absorb, are nature's method of extracting nitrogen from the air and soil. They are a key component of the basic microbial product. There are nitrogen fixing bacteria strains in our basic product for leguminous crops, cereal crops such as rice, wheat and corn, and forage grasses, sugarcane, sorghum, maize and rice. There are also microbes from other functional areas which work synergistically to fix nitrogen.

There are strains which work in aerobic and anaerobic conditions; strains which work in acidic conditions and strains which work in alkaline conditions. So, one functional area of *SumaGrowtm* has multiple strains of microbes which work on multiple crops in multiple environments.

How important is naturally occurring nitrogen fixing? Biological nitrogen fixation is an essential natural process that supports life on Earth concerning the environment, energy, nutrition, and agricultural sustainability. The heavy use of chemical fertilizers containing nitrogen, often employed for increasing crop productivity, result in leaching of nitrates which at high levels pose a health hazard to humans and wildlife. Furthermore, when soils become anaerobic, nitrate (NO_3) is reduced to nitrous oxide (N_2O), which is over 300 times more potent than carbon dioxide (CO_2) as a potential greenhouse gas.

SumaGrowtm formulations decrease the need for nitrogenous fertilizers by 50+%. At the global level, nitrogen is by far the most important element in the traditional N-P-K fertilizer, accounting for roughly half of total fertilizer use.

INCREASE IN WATER EFFICIENCY

To be clear, plants grown with products containing *SumaGrowtm* still need the same amount of water to grow, however, the water efficiency is increased sufficiently to allow crops to grow with less rain or irrigation water.

There are several modes of action which create better water efficiency – reduced compaction/increase in water holding capacity, control/reduction of salinity, and improved water quality.

The ability of soil to hold water is related to the amount of compaction of the soil – high compaction equals reduced water holding capacity. Products containing *SumaGrowtm* alleviate this condition by reducing the compaction.

The mineral/scale barrier – known as the “bowl effect” or “mineral bowl” – is dissolved which enables the root cilia to expand further into the soil. The rigorous and maximized efficiency of the root system promotes healthier, greater yielding plant growth. Look at these soybean root systems:



Both pictures: conventionally grown root system on the left and BSEI grown roots on the right

One way of measuring compaction is by using a penetrometer – think of a giant needle which gets inserted into the ground, typically until it registers 300 psi, the point where roots can no longer grow. A typical truck farm vegetable may have a reading of 5-6 inches which was increased to 10-17 inches in several independent, controlled studies after using a product containing **SumaGrow™**.

In one of our better results, Holden Research tested cabbage in California. With only a 20% reduction in fertilizer and the addition of a product containing **SumaGrow™** penetrometer depth increased from 6 inches to 17.8 inches.

Since topsoil dries out from the top, down, when the top six inches of soil are out of moisture the grower standard crop was without water, however, the treated plot still had 11.8 (17.8 – 6) inches of soil with moisture in it for the roots to extract. (As an aside, the top 6 inches of soil contain far fewer nutrients than the soil between 6-18 inches, so roots beyond six inches can access higher nutrient soil which leads to higher nutrient crops.)

Petrochemical based fertilizers leave behind salt residues. Salts in the soil can wick away moisture from the plant roots which is why soils with high salinity are less desirable and sometimes unable to grow crops. The more fertilizer used, the more water which is needed.

Microbes excrete a substance known as exopolysaccharides (EPS) which encapsulate salts, preventing the salts from absorbing moisture. This is a first step in bio remediating the soil of excess salts. With less moisture being absorbed by the salts, there is more moisture available for plant life.

In a sports turf field trial with the City of Costa Mesa, California, in less than three months, the treated fields achieved a 26% reduction in salinity, according to third party laboratory analysis.

The moisture in the soil also went up by 10% and the Sodium Absorption Ratio (SAR) went down 17% (lower is better). The SAR is a test of water *quality*, not quantity.

There are also indications land currently considered incapable of growing crops due to small amounts of water or salinity in the soil may become arable land. This feature alone may be worth the purchase price of **SumaGrow™** products as it may mean the difference between being able to grow a crop, or not.

PESTICIDE REDUCTION

Pesticide is a general term which can further segmented into insecticides, fungicides and herbicides. BSEI estimates the reduction in *insecticides* to be approximately 90%. Generally speaking, insects prey on weak plants and **SumaGrow™** plants are much stronger than industrially grown plants as evidenced by higher brix, chlorophyll and protein levels, however, there are some insects, such as Army Worms, which eat everything in their path and **SumaGrow™** plants would still be susceptible to this type of insect.

In addition to healthier plants having fewer disease/insect issues, there are two other modes of action **SumaGrow™** products have against insects – higher brix levels and quorum sensing. The higher brix levels (natural sugars) we have documented in a number of crops are the plants' natural protection

system. Insects don't have livers to digest sugars so the sugars stay in the insects' stomachs, ferment and kills them. Low brix levels are signs of less-than-healthy plants so having insects kill the less-than-healthy plants is Mother Nature's way of promoting the survival of the fittest.

As an aside, insects are attracted to free nitrogen ions. Most fertilizers consist of, or break down into, free nitrogen ions.

Microbes produce an electromagnetic frequency; the more microbes, the stronger the signal, known as "quorum sensing." In layman's terms, this signal basically tells insects to stay away. Obviously, **SumaGrowtm** increases the number of microbes and hence, the strength of the electromagnetic signal.

BSEI estimates a 50% reduction in *fungicides* due to the natural bio-pesticides included in the formulation.

Getting more technical, the bio-pesticide (bio-control) function is comprised predominately by *Trichoderma*. *Trichoderma* are included in **SumaGrowtm** as a bio-pesticide agent against fungal diseases of plants. The various direct inhibition mechanisms against plant pathogens include antibiosis, mycoparasitism, inducing host-plant resistance to stress through enhanced root and plant development, solubilization and sequestration of inorganic nutrients, inactivation of the pathogen's enzymes, and competition for nutrients or space.

The bio-pesticides generally grow in their natural habitat on the root surface, and so affect root disease in particular, but can also be effective against foliar diseases. Once the bio-pesticides come into contact with roots, they colonize the root surface or cortex, depending on the strain. The best strains will colonize root surfaces even when roots grow three feet below the soil surface. In addition to colonizing roots, *Trichoderma* attack, parasitize and otherwise gain nutrition from other fungi. Since *Trichoderma* grow and proliferate best when there are abundant healthy roots, they have evolved numerous mechanisms for both attack of other fungi, and for enhancing plant and root growth.

Different strains of *Trichoderma* control every pathogenic fungus for which control has been sought, however, most *Trichoderma* strains are more efficient for control of some pathogens than others. The recent discovery in several labs that some strains induce plants to "turn on" their native defense mechanisms offers the likelihood that these strains also will control pathogens other than fungi.

Because bio-pesticides contain multiple modes of action, they are well suited for rotation in pest management programs. For example, a bio-pesticide may create holes in the gut of the pest (fermented sugars), whereas conventional pesticides are often neurotoxins.

There is far less data on the bio pesticide benefit using products containing **SumaGrowtm** than the other benefits, however, we do have end user reports on our success with the following:

- Bananas – sigatoka, nematodes (documented by the Dominican Institute of Agriculture and Forestry Research (IDIAF))
- Black Pepper -- quick wilt (Vietnam)
- Chestnut trees -- Chestnut blight (*Chryphonectria parasitica*)
- Coffee -- roya, or leaf rust (Honduras)
- Sugar cane -- root fungus (Guatemala)

Tomato – plaque, powdery mildew (internal testing by Dr. Lalitha)
Wheat -- rust, fusarium

Some users report a reduction (generally 50%, especially when used on turf) in *herbicides* (used to kill weeds), however, the reports are still anecdotal, so BSEI states there is a zero reduction in herbicides, as unfortunately in this case, **SumaGrowtm** makes everything grow better!

For those users reporting a reduction in herbicides, they generally have mixed the herbicides with **SumaGrowtm** products and it is believed the **SumaGrowtm** products act as a carrier and transmit the herbicide to the root tips, generating a more effective distribution and thus a higher kill rate of the weeds.

Besides the cost, the adverse environmental impact of pesticides is substantial. An array of pesticides belonging to different chemical classes is used for controlling a variety of plant diseases. A number of pesticides are recalcitrant to degradation, persist in the environment, and enter the human/animal food chain constituting a threat to public health and a potential hazard to the environment. Some are toxic to humans even at parts per billion levels. There is increasing public concern regarding the continued use of chemical pesticides at high levels and there is a growing need for developing environmentally friendly approaches to control common plant diseases and contribute to the goal of sustainability in agriculture production.

Please note; while there have been successes treating various plant diseases and insect issues, these benefits are not our primary selling points. In fact, in the U.S., we are not even allowed to sell our product as a bio pesticide since we are not licensed by the FDA to do so. Any benefits on plant disease should be considered a secondary benefit – no customer should use our products based on the ability to control a disease. Yield increase is our primary benefit.

Furthermore, in dealing with plant diseases and insect control, products containing **SumaGrowtm** work best as a *preventative*, not a *curative*. Healthy plants have fewer diseases and we grow healthier plants. Just like a human with an impaired immune system is more likely to catch a cold than a human without an impaired immune system. The higher nutrient levels previously discussed are evidence of healthier plants as are the numerous points of test data showing longer roots, thicker stalks, more leaves, bigger leaves, etc.

If the plant already has a disease or is infested with insects, it is much more difficult for **SumaGrowtm** products to treat. Please remember, our products work by making the soil healthier – they are not fertilizers, nor pesticides, and the time it takes to work is much longer than a fertilizer or a pesticide. In one of our studies, by an independent PhD, Dr. Allen Williams, at the LHOP Ranch in Kansas, the brix levels were observed weekly and it took four months for the brix levels to reach their maximum level.

BETTER ABILITY TO WITHSTAND STRESSES

Products containing **SumaGrowtm** have withstood weather stresses, such as drought, high winds and frost, much better than conventionally fertilized fields. Unfortunately, this is a difficult benefit on which to conduct studies, so there is a heavy reliance on anecdotal evidence, though, there is the ability to “connect the dots” of data to support these claims.

A large cotton farmer reported winds in excess of 50 MPH flattened his entire 6000 acre farm, except the cotton treated with a product containing *SumaGrowtm*. There are numerous studies which document increased root growth for products containing *SumaGrowtm* – mass and depth – in fact; increased root systems are probably the most noticeable feature of *SumaGrowtm* treated crops. It is easy to believe the increased root systems helped the cotton plants withstand the high winds.

Below is a picture of control versus *SumaGrowtm* treated soybean roots which is featured in a Forbes.com article.



Conventionally fertilized roots on left, *SumaGrowtm* product roots on right.

Higher brix levels, again well documented, have another benefit in addition to those already mentioned -- the ability to better withstand frost due to the higher sugar content, as the more sugar there is the lower the freezing point becomes. The pictures below present a stark comparison between conventionally fertilized fields and *SumaGrowtm* fields on the Thomas Elliott Farm in North Carolina:



Conventionally fertilized tobacco



SumaGrown tobacco on the same farm

Not only did the tobacco, treated only with manure and a product containing *SumaGrowtm*, withstand several frosts, the tobacco buyer stated it was the “biggest and best tobacco he had ever seen.”

The water efficiency of products containing *SumaGrowtm* has been previously discussed, however, the impact in drought conditions is nothing short of startling. Farmer Kevin Dilap of Illinois had a successful corn harvest, which was newsworthy enough to be written up in Barron’s Online, with only 2/10” of rain between March 1 and July 25 on his non-irrigated fields.

Below are pictures from a severe drought area of Texas in 2011 showing conventionally fertilized corn versus *SumaGrowtm* treated corn. The untreated corn, on the left, has a noticeable lack of germination and if you look closely, no ears of corn, while the SumaGrown corn on the right has a much higher germination rate and at least one ear of corn on nearly every stalk.



Conventionally fertilized corn during drought conditions



SumaGrown corn during drought conditions

III. THE COMPANY AND PRODUCT

BACKGROUND OF BSEI

BESI's *SumaGrowtm* products have been in development since 2000, with field trials on an informal basis starting in 2003, and then three years on a formal basis including extensive greenhouse testing conducted at Michigan State University starting in 2006 and testing on over 200+ outdoor test plots. Sales began in 2010 and, since then, the product has been used on thousands of farms under real world conditions.

The informal testing was conducted on a farm in Mississippi which was initially treated with an early version of the current product and soon became a local attraction due to the size and quality of the crops. The initial test plot has now been growing various crops without any petrochemical based fertilizer for ten years.

In 2006, in addition to the test farm in Mississippi and greenhouse testing at Michigan State University, farmers in Michigan, Mississippi, Alabama, and Arkansas planted 10 acre test plots of different commercial crops. While the application of the product was inconsistent as some farmers missed the first treatment, the results were still notable.

The cotton plot below (center) missed the recommended first treatment and only received the second treatment. It was late in showing a difference between the treated and control acreage; however, the difference by the end of the season was significant. The crop exhibited a deeper and more extensive root system; thicker stalks, taller plants and a deeper green color. The crop proved to withstand stresses better as a wind storm near the end of the season blew down the control crop, yet the treated portion withstood the wind and was able to be harvested one week earlier (which received a higher price at the cotton gin) than the control crop. The treated portion generated an additional 8% of ginned cotton (lint) per acre as well as a significantly greater seed quantity.



Left -- Below the waist without BSEI

Center -- chest high with BSEI Products

Right -- With two treatments over six feet tall

Research and development continued at the end of 2006 and the beginning of 2007 with greenhouse research conducted at Michigan State University (MSU). MSU started with the base formulation provided by BSEI and refined it further. They created five blind formulations, including a control, which was tested on a farm in the Hattiesburg, MS area on virgin land during the 2007 season on over 200+ test plots. Tests were conducted on row crops – corn, soybean and cotton, as well as vegetables -- yellow squash, tomatoes, green beans, bell pepper and banana pepper. The results were significant, including six-foot-tall cotton and a 61% increase in the squash yield.

Additional farmers came on board testing the product on their own farms. Another benefit became noticeable when our test plots were able to harvest corn while others in the area had to bale the corn for hay due to the drought-like conditions. The same cotton farmer, who applied the product in 2006, used the product again in 2007 and achieved in excess of a 20% increase in yield.

The Research & Development (R&D) efforts in 2008 were spent primarily perfecting the manufacturing (cultivation of microbes) process. This resulted in increasing the concentration of microbes, a truly significant achievement, though due to regulatory issues, we list the microbes at lower levels on our labels than what our Quality Control tests show.

In 2009, approximately 3000 acres of actual users were planted, primarily in Michigan since the Mississippi production facility was not yet approved to cultivate agricultural microbes. (BSEI received approval to manufacture July 28 and approval to sell on August 21, 2009.) Only small quantities could be made at the research labs at MSU. Product made in Michigan was allowed to be sold in Michigan. The largest amount of acreage treated on a single farm in 2009 was 500 acres of corn, planted in several configurations – product applied on the ground, in furrow and foliar, with various amounts of fertilizer. Generalizing the overall results, the yield increased 30+% while petrochemical based fertilizer usage was cut in half.

BSEI had a similar result with 120 *SumaGrow*[™] treated acres of hay (Bermuda grass) outside Houston, TX. The weather did not allow harvesting of the control and treated acreage at the same time to make an accurate comparison. The BSEI treated acreage, without any fertilizer, had a yield increase of at least 20% compared to the conventional fertilizer grown acreage, at a cost of less than one-half compared to conventional fertilizer.

A second year user in Pennsylvania who grows some corn, several vegetable crops and food plots may be our best testimonial. In 2008, he reduced fertilizer by 50%; in 2009, he completely eliminated conventional petrochemical based fertilizers. A written testimonial letter from this user states our product is a “*miracle*.”

The results from 2010 included an additional university – Mississippi State University -- validating the product, a 200 acre test demonstrating a significant increase in brix levels and dramatic yield increase compared to both an organic broiler litter and urea on eight different varieties of pasture grass supervised by a third party PhD, a farmers’ co-op achieving over a 20% increase in corn yield, and numerous farmer results of crop yield increases side by side (A/B splits) with treated versus control plots.

There were two significant findings from the 2010 results – the data clearly showed the fertilizer *must be reduced* to achieve better results and the bio pesticide function of the product was demonstrated *after plants had been infected* – a *curative*, not just a *preventative*.

Since 2010, BSEI has been recommending at least a 50% reduction in all crops from “grower standard” fertilizer amounts and the complete elimination of fertilizer for some crops such as grasses. The other fertilizer related result is that the highest *quality* crops (defined as highest chlorophyll, higher brix levels or higher protein levels) were achieved with zero fertilizer, though the quantity was not necessarily the highest quantity.

Prior to 2010, BSEI had assumed the bio pesticide function operated by making the plants healthier and therefore more disease resistant, however, there were numerous customer descriptions of the product being used after an infection and fighting off the problem, or least keeping the crop alive long enough to harvest.

Marketing efforts were continually treated with a response, stated or unstated, of “it’s too good to be true” so in 2011, additional resources were put into data collection with credible third parties. Two notable parties acknowledged the benefits of our *SumaGrow™* products. The first was the Illinois Soybean Association Yield Challenge where BSEI came in first (District 9, the only district entered) beating Monsanto which came in second. The second was being named the Grand Award winner in the Green category of the Best of What’s New issue (December 2011) of Popular Science magazine.

In 2012, the product efficacy and data collection was expanded even more to gather data internationally, including significant numbers of trials in India (over 500), China, Dominican Republic and Vietnam.

SumaGrow™ AND HOW IT WORKS

BSEI believes the design of the *SumaGrow™* product line is better than any of its competitors since it takes a holistic, synergistic approach to boosting crop yields and decreasing inputs in a sustainable manner. The documented benefits achieved with *SumaGrow™* products are clearly better than any known competitor.

BSEI’s liquid products (consisting of bacteria and fungi) are eco-friendly, broad spectrum, stimulative, poly-microbial inoculants, with multiple, complementary functions. The product, in layman’s terminology, consists of “Concentrated Mother Nature.” Perhaps, even more importantly, is what the product line is NOT. The products do not contain genetically modified organisms (GMO) nor growth hormones whose long-term effects are unknown. Nor are the products irradiated or contain any chemicals which can be harmful to humans, livestock or the environment. They are not petrochemical based nor are they a “compost tea.”

BSEI’s products are akin to feeding a human organically grown food and nutritional supplements in a nurturing environment rather than junk food and steroids in a neglectful environment. Conventional farming utilizing petrochemical based fertilizers – Nitrogen, Phosphorus and Potassium (N-P-K) – is the equivalent of using steroids; they will produce gains in the short/medium term while causing environmental degradation in the long term, likewise for pesticides.

Eco-friendly would typically mean not harmful to the environment. *SumaGrow™* products go beyond eco-friendly. In addition to NOT using harmful chemicals, *SumaGrow™* products rehabilitate the soil, making the soil healthier, and are highly compatible with sustainable farming. Our products

will enhance the soil's ability to naturally remediate existing soil contaminants, improve its water retention capacity, improve its chelating abilities to prevent the leeching and runoff of pesticides and other chemical applications, and improve the soil's organic mass for sustainable production of plant life.

SumaGrow™ products are made from cultivated, not genetically modified strains of microbes. Every product has at least six strains of microbes. BSEI products are the most complete product on the market, with at least five functions per product. In other words, our product is a multi-vitamin and our competitors' products are simply Vitamin C. Our product would be more correctly referred to as a perfect food since it contains (or has the ability to produce or mobilize) vitamins, minerals and organic pesticides, and adjusts its own environment by correcting the pH and allowing greater efficiency in water utilization.

Our basic product is a broad spectrum product, capable of working on a variety of plants, including legumes, non-legumes, vegetables, cereals, ornamentals, and fodder crops, in a variety of environments, such as high and low pH, wet and dry soil, and in relatively cold, temperate and hot climates. In layman's terms, our product has the equivalent of the Army, Air Force, Navy and Marines, ready to fight whatever battle in whatever conditions it encounters.

The BSEI product formulations also include liquid humates and plant micro nutrients. Humates are the backbone of healthy soil. They promote the growth of beneficial microbes and give the soil the proper compaction, cation exchange capacity (CEC), and the ability to retain water and nutrients while making them readily available to plants.

Humate derivatives are mixtures of humic, ulmic and fulvic acids. They are products of organic matter transformation by the soil microorganisms. Organic matter (OM) is the source of energy and food supply for microbes, which allows BSEI to ship its microbial formulations as a liquid since the humates provide a food source for the microbes. Additionally, humic acid derivatives have several known benefits to agriculture, such as increasing seed germination (greater and more rapid), improving trace element nutrition through chelation, and improving moisture conditions.

Polymicrobial formulations have the potential to greatly increase crop productivity with less dependence on petrochemical fertilizers and chemical pesticides, and alleviate negative health and environmental consequences associated with their use.

The following is a specific list of performance features for **SumaGrow™** microbial formulations:

Improves nutrient and water uptake

Improves root and plant growth and crop yield

Improves plants' efficiency in using solar energy

Reduces stresses of transplanting and drought

Increases Cation Exchange Capacity (CEC)

Reduces pest infestations of insects, harmful microbes, and nematodes

Increases effects of beneficial microbes and organisms

Improves soil health and water retention

Stimulates development of balanced microflora populations

Increases bioactive substances needed for plant growth and development

Reduces reliance on chemical fertilizers and pesticides

Improves the taste and quality of crops

Helps release micronutrients and trace elements, making them available to plants

Stimulates germination

Reduces amount of toxins in soil associated with harmful organisms

Increases healthy decomposition of organic matter and reduces putrefication

WHY *SumaGrow*[™] PRODUCTS ARE BETTER THAN THE COMPETITION

While the idea of microbial inoculants for stimulating crop production is not new, careful and deliberate design of a formulation to contain multiple, naturally occurring phylogenetic groups of organisms with complementary functionalities, and putting them together in a manner in which they retain viability over a long period of time at ambient temperature, with little or no need for added chemical fertilizers and pesticides is innovative.

SumaGrow[™] is an innovative, breakthrough product for five reasons. First, the base product contains at least six different microbial strains compared to competitors with typically one strain. The greater the number of strains, the harder it is to manufacture since the cultivation time varies by strain and strains must be compatible. **BSEI's base formulation with 6+ strains is a significant barrier to entry.** While any decent laboratory should be able to identify the majority of strains of microbes in our products, since the cultivation time varies – one strain may take 17 days and another 27 days – the manufacturing process would be very difficult to determine.

Another company trying to “tweak” the formula by replacing a particular microbe or function -- for example, resistance to disease – encounters the issue of compatibility between microbes. Much like the animal kingdom, where some animals can co-exist peacefully, and others will attack and eat each other. Our basic formula consists of complementary microbes.

Second, the product has five functions, such as nitrogen fixing and bio-pesticide - compared to competitors with typically one function and rarely more than two functions. Having more than one function is relatively unique in the industry, for example, there are competitive products containing *Trichoderma* which are formulated for pest control only. Rarely would these one function products contain more than one genera of microbes.

Third, unlike its counterparts, some of whom require refrigeration, *SumaGrow™* formulations retain viability over a long period of time at ambient temperature. This is significant when considering where the product may be utilized. Third world countries are known to have a lack of infrastructure to be able to transport products in a timely manner. While other products may be essentially useless when they finally arrive, *SumaGrow™* products would still be able to perform.

Fourth, *SumaGrow™* products are highly concentrated compared to its competitors with lower concentrations; we typically use only one gallon per acre (10 liters per hectare). Many competitors have a problem concentrating their product to a meaningful level to work in real world conditions which is why some competitors' products are sold on to greenhouse growers.

Fifth, the product actually works! The most obvious benefit making BSEI's microbial products better than the competition is they actually work. J. Brockwell and P.J. Bottomley (1995) reported in *Recent advances in inoculant technology and prospects for the future*, published in Soil Biology and Biochemistry that many of the commercial microbial inoculants have not lived up to their claims; **90% of all inoculants have no practical value** [emphasis added] whatsoever on the productivity of legumes.

Even for the competitors' products which do work, none are reporting the combination of such significant yield gains (compared to "grower standard," not compared to a control of nothing) while being able to reduce conventional fertilizer by such dramatic amounts as BSEI's microbial formulations.

The product line currently for sale by the Company is a "one size fits all" solution for all agricultural crops and another for turf since the product is intended to make the soil healthier.

BSEI's continuing R&D has identified some formulation combinations which will further enhance the results for specific crops due to their specific needs – beans, for example, need additional nitrogen, and rice needs a lower pH compared to most other crops. This can be as simple as adding extra nitrogen fixing bacteria for the crops which need extra nitrogen. These crop-specific products are internally referred to as our Phase 2 products. Our current Phase 2 products include treatments for golf courses and medical marijuana.