The Use of Humic Substances in Agriculture: Origins, Science and Applications

Contents

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EXECUTIVE SUMMARY

Today's farmers continue to face serious challenges. Concerns regarding soil and water conservation, environmental impacts and new government legislation are important issues that need to be considered, as well as the steadily increasing global demand for food and fuel.

A survey of the modern farm industry shows that selective breeding and application of nitrogen-based fertilizers have resulted in yields that far exceed those of the early 20th century. However, demand for organic produce in North America is increasing rapidly and farmers wishing to develop environmentally friendly but profitable practises must look for additional ways to improve yields.

Humic substances have excellent potential for increasing crop and livestock productivity without harming the environment. These coal-derived organic matter substances have been known for over a hundred years and are similar to a highly concentrated version of the naturally occurring organic matter in soil (humus). New scientific studies show that humates can be a cost-effective practise to increase yields without the associated environmental impacts of bringing more acreage under production.

Humic substances have excellent potential for increasing crop and livestock productivity without harming the environment.

In the following pages, we'll take a close look at humic substances: what they are, where they come from and how they work in a variety of conventional and organic agricultural applications. The best ways for today's crop farmers, turf growers and livestock farmers to implement the use of humates in their practises are discussed.

1. THE INCREASING DEMAND FOR FOOD: ISSUES FOR TODAY'S FARMER

Farmers face multiple issues regarding sustainability and continued profit from their operations. Environmental pressures have increased dramatically in the past 20 years, organic products are in huge demand and the global need for food is rapidly increasing. Farmers must navigate a minefield of business, technical and regulatory issues while continuing to increase their product yields from existing acreage. This can be a tough challenge.

In a 2007 study[1], the Agriculture Institute of Canada listed a series of key issues facing farmers that included:

- increasing global demand for food and fuel
- soil management and sustainability
- water conservation
- land availability and cost
- government regulations
- transportation and labour costs

Some of these issues arise from the dramatic shift away from conventional, chemical-based farming methods to a new focus on organic farming and sustainable soil management practises. In its 2009 report on marketing U.S. organic food[2], the United States Department of Agriculture stated that retail sales of organic foods rose from $3.6 billion in 1997 to 21.1 billion in 2008 – an increase of 586%.

Within this framework, both organic and conventional farmers are under pressure to implement environmentally-friendly solutions that are cost effective, work within new regulations and yield high quality products. How can today's farmer maintain profitability? Enterprising farmers in Canada have formed new partnerships, diversified their products, begun direct marketing campaigns and adopted new technologies for modelling production costs[1].

Both organic and conventional farmers are under pressure to implement environmentally-friendly solutions that are cost effective, work within new regulations and yield high quality products. How can today's farmer maintain profitability?

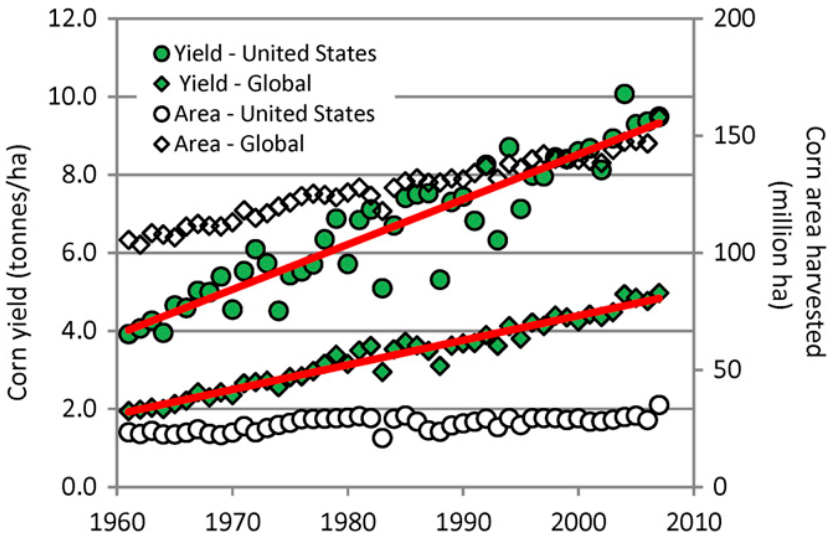
Yet the heart of the problem continues to be producing more food from the same acreage.

In the following pages, we'll take a look at why increasing yields from existing acreages is the most viable solution for many farmers. We'll briefly review some of the methods that have increased efficiency in modern agriculture and then go on to discuss humic substances as a new solution applicable to both conventional and organic farming.

2. INCREASING YIELDS: PAST, PRESENT AND FUTURE

Yields Have Steadily Increased in the Past 80 Years.

In the first third of the 20th century, a farmer would expect a corn yield of approximately 1.6 tonnes/ha. Since then, the yield per hectare for corn in the US has steadily increased to around 4.0 tonnes/hectare in 1960 and an average of 9.4 tonnes / ha today[3]. The chart shows annual corn yield averages and area planted in the United States and the rest of the world (Source: Food and Agriculture Organization of the United Nations[4]).



Better fertilizer management, more efficient farming machinery and the breeding of hybrids with better stress tolerances have all contributed to increased yields. In his report "The Contribution of Breeding to Yield Advances in Maize"[5] Dr. Duvick of Iowa State University says:

"Rates of gain for yield have changed as new agricultural technologies have been developed and adopted... about 50% of the yield gained between the introduction of hybrid corn, and today is derived from breeding and the remainder from improved agronomic practices."(2005.)

For livestock farmers, yield increases have arisen principally from breed substitution, cross-breeding and within-breed selection, but also from advances in nutrition and management. Globally, the

average carcass weight for cattle was 160kg in 1960 and increased to around 200kg in 2008[6]. Similar per cent increases have been reported for pigs.

Modern farmers use precision technologies to monitor feeding and GPS tracking to analyze equipment use and plantings. The newest trends in crop development include the use of hybrids with genetic biotechnology traits – for example, corn hybrids with resistance to corn borers and rootworm. The application of biological growth promoters (hormones) and better agronomics (including planting density, fertilizer use efficiency and better soil management) have also increased yields. However, some of these practises are coming under scrutiny as being unsustainable – for example, many soils are becoming depleted of their essential carbon content.

Global Demand for Food, Fuel and Animal Feed is increasing

While productivity is at an all-time high, so is the demand for food, animal feeds and fuel. Further significant increases are predicted - demand for cereals is projected to reach some 3 billion tonnes by 2050, up from today's nearly 2.1 billion tonnes[4]. This is because:

1. The global population is booming, particularly in developing countries. This means increased demand for grain as a food source.

2. Disposable income has risen in developing countries, allowing people to consume more meat and consequently raising the world demand for animal feed.

3. Concerns about long term prospects for the world's oil supply have led to development of alternative biofuels produced from corn and wheat.

Overall, the demand for corn and wheat to meet these three demands is expected to increase over the next decade by about 15% (an increase of 200 million tonnes per year) [4].

Better Yields are Still Attainable Using Environmentally-Friendly Methods

Despite the adoption of modern farming methods that contribute to relatively large yields, core productivity still depends on many basic factors, including soil health, water and nutrient availability and, in livestock, the efficiency of feed conversion. Agriculture giant Monsanto predicts that agronomic contributions to the rate

of yield improvement (planting density, fertilizer use efficiency, and improvements in soil management) will continue at current historical rates despite widespread adoption of bioengineered strains[3].

Agricultural yield can be increased either by increasing the area under production or by improving the productivity of existing farmland. In general, a better yield from existing acreage is the preferred solution, since increasing the land area under production involves large scale disruption of ecosystems and a significant contribution to greenhouse gasses.

Humic substances are a class of materials with significant and underutilized potential to increase yields from existing acreage. In the next section, we'll explain what humic substances are and where they come from.

3. AN UNTAPPED RESOURCE: HUMIC SUBSTANCES

Both conventional and organic farmers need a solution to increase the output and profitability of their operations while avoiding many of today's environmental concerns. Humic substances may provide such a solution - they have the potential to increase crop yields from existing acreage without causing further problems with soil quality. These organic components of the Earth's sediments and coal seams have been known for many years to improve plant growth and soil health, but it is only recently that scientific testing and field trials have been applied to study their specific effects. So, what are humic substances?

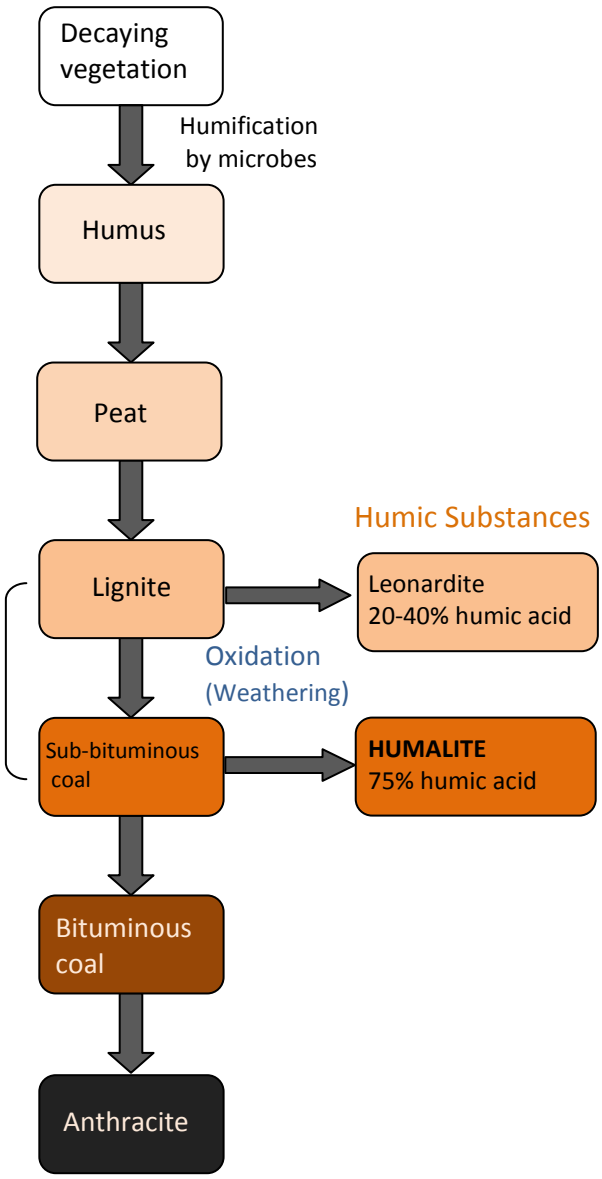
Humic Substances Are NOT Compost

First, some myth busting. Humic substances are **not** compost or manure. What they are is the major organic component of the Earth's soils and sediments created from decayed biomatter by a process called humification. After plants die, their organic biomatter is degraded by microorganisms in soil to eventually produce dark-coloured, highly complex chemicals (humus). Soils containing high levels of humus have a rich dark brown or black appearance and have been valued for centuries as a basis for good quality, high yield crop growing.

Humic substances are the major organic component of the Earth's soils and sediments, created from decayed biomatter by a process called humification.

Humic substances are found in especially high concentrations in peat and brown coals. Different grades (or ranks) of coal are formed by geologic compression of soil layers over millions of years. The lower ranks of coal such as lignite and sub-bituminous

coals are not efficient as fuel, but contain large amounts of organic matter. As the chart shows, when these low rank coals are oxidized or weathered, they form mineable humic substances; humalite in Alberta and leonardite in other parts of the world.



Humates are the Active Ingredients in Humic Substances

Humic substances can be separated into their active components (humates) under various acid and alkaline conditions:

- Fulvic acid dissolves at any pH and is especially high in oxygen.
- Humic acid is soluble at pH higher than 2 and contains balanced carbon and oxygen.
- Humin is insoluble and has very high carbon levels.

Humates are large collections of relatively low molecular mass components and have been characterized as colloids – huge, negatively charged associations of bioactive molecules that change their form depending on the conditions. This allows them to act as a buffer or reservoir for plant nutrients in soil. New research shows that humate molecules can also form water-attracting layers on soil particles, which improves the solution of nutrient hydrocarbons into water[7].

High Quality Humates are Mined in Alberta

The quality of mined humates depends on a high concentration of the most active components, especially humic acid. Leonardite has been produced in North Dakota since the 1920's and significant deposits are also found in New Mexico. Humalite is mined only in Alberta. Analysis of the percentage humic acid content of dried humate samples from New Mexico, North Dakota and Alberta shows that humalite has the highest concentration of humic acid, between 75 and 90% (Loring and ALS Laboratories[8]). It also has low ash and low toxic metal content compared to other sources.

In agricultural applications, humates have the advantage that they are 100% organic, compatible with sustainable farming practises and help to address environmental issues such as nitrogen runoff.

4. HUMIC SUBSTANCES PUSH CROP YIELDS HIGHER

While humates have been known in agriculture for many years, it is only recently that scientific research from universities and agricultural centres has begun to confirm their effects on soil and on plant nutrition. Humates can influence yields by affecting soil texture, water retention and nutrient buffering capacity. They also directly promote plant growth and uptake of nutrients from soil.

Plant Nutrition Depends on Many Factors

The final yield derived from plants grown for food is affected by as many as 40 different variables of climate, soil health and farming practises. The major categories are given in the chart. As we'll see, many of the main indicators of soil health can be influenced by humic substances – those affected are indicated in the chart with an asterisk.

Soil Fertility Is Improved By Humates

The overall strategy for increasing crop yields and sustaining them into the future has to include the management of soil as a storehouse for nutrients[9]. Many farming practises that have prevailed since the 1950's break down soil carbon into carbon dioxide that is released into the atmosphere. It has been reported that the carbon content of some mid-Western soils has been reduced from 20% to around 1% in the past 40 years[10]. Clearly, new soil conservation practises are necessary and increasing soil organic matter content is of high priority.

The capacity of soil to support plant root growth depends not only on the concentration of nutrients but also on its texture, organic matter content, acidity, depth and water-retention capacity. Humic substances, especially those containing high percentages of humic acid, are already used in environmental recovery applications such as soil remediation from hydrocarbon and salt contamination[11]. Some effects of humic substances that

Factors Affecting Crop Yields

CLIMATE
- Sun
- Wind
- Temperature
- Precipitation
- Frost free days

SOIL HEALTH
- Texture*
- Aggregate size*
- Cation exchange capacity*
- Water retention*
- Organic matter*
- Nutrient availability*
- Nitrogen fixation*
- Microbe numbers*

FARMING PRACTISES
- Tillage
- Seedbed firmness
- Seeding depth
- Seed treatments*
- Fertilizers*
- Pests – weeds
- Pests – diseases
- Pests – insects

are relevant to agriculture are improved soil texture, water retention and cation exchange capacity.

Soil Texture and Water Retention

Two recent studies have looked at the effect of coal-derived humic substances on water retention and structural stability of soils. One report concluded that amending three different types of loam with low rates of humic substances (100-200 kg/ha) improved the aggregate stability and greatly reduced the disaggregating effects of wet/dry cycles[12]. In a second study, the same scientists also showed that humate addition significantly increased the available water capacity and field capacity of several degraded soil types and improved the aggregate stability by 40-120%[13].

Soil Cation Exchange Capacity and pH

The cation exchange capacity of soil is a measure of its ability to hold and release various compounds and elements. Most of the major nutrient elements for plant growth are positively charged nutrients such as potassium (K^+), ammonium ($NH_4^{+)}$, magnesium (Mg^{++}), iron (Fe^{++}), calcium (Ca^{++}) and zinc (Zn^{++}). Hydrogen (H^+) is not a nutrient but its concentration affects soil pH.

A sandy soil with low organic matter will have a low CEC in the range 1-10 ME; fulvic acid has a CEC of 1400 ME...

Clay particles, organic matter in soil and humates all have a negative charge and therefore attract and adsorb nutrient cations onto their surface, holding them in the soil and making them available for uptake into plant roots. A sandy soil with low organic matter will have a low CEC in the range 1-10 ME, while soils with higher clay content and more organic matter range from 10-50 ME. In comparison, humic acid has a CEC of 450 ME and fulvic acid has a huge CEC of 1400 ME, so combining these substances with fertilizers makes a big impact on the overall CEC of soil[14].

In summary, humates improve soil health by:

- Improving texture: loosening of clayey soil, better aerification and better seed contact.
- Improving water retention: reduced runoff.
- Increasing cation exchange capacity.

Concerns Addressed: Loss of carbon from soils

Humates are effective soil conditioners that replace lost carbon content and can be used as part of sustainable, organic soil management practises.

Humates Increase Soil Microbes

Fertile soils contain hundreds of millions of microbes in a single gram. The microbial biomass in 1000 square feet of typical fertile soil includes 12 pounds of bacteria, 17 pounds of actinomycetes (bacteria that produce antibiotics), 35 pounds of fungi, 8 pounds of protozoa (decomposers) and 3 pounds of algae[15]. Under favourable conditions of moisture, aeration, pH, temperature and available carbon and inorganic nutrients such as nitrogen, soil has enormous potential for beneficial microbial activity.

What are all these microbes doing? First, they are stabilizing soil structure by producing “gummy” substances called polysaccharides and mucilages. These are somewhat water resistant and help prevent soil from crumbling when it gets wet. Fungi in particular are important for holding soil together. They grow by producing microscopic threads that interweave and surround soil particles, enclosing them almost like a hairnet. Since carbon in aggregates is more resistant to degradation than free carbon, fungi also help to conserve the available carbon in soil.

One of the most important functions of soil microbes is cycling nutrients such as nitrogen, carbon, phosphorous and sulphur. It is only through the action of soil microbes that these nutrients are released from organic fertilizers and can be used by plants. An example of this mineralization process is the conversion of proteins to their constituent carbon dioxide, ammonium and sulfates.

Another process carried out by microbes is nitrogen fixation, the capture of atmospheric nitrogen into microbial cells. Many of these beneficial nitrogen-fixing bacteria actually live in specialized structures (rhizomes) on the roots of leguminous plants such as beans, while others are free living in the soil[15].

Studies on Humates and Soil Microbes

The effect of humic acids on the metabolism and proliferation of soil microbes was tested by Dr. Visser of Laval University, Quebec[16]. The addition of humic acids to microbial cultures at concentrations of 30mg per litre resulted in proliferation of soil microbes up to 2000-fold. In the presence of humic substances, certain microbes also appeared to proliferate on substrates that they could not utilize originally, suggesting that humates can alter the metabolism of microbes. Dr. Visser commented that the effects of humic acids on microbes appeared to be comparable to that of surfactants – chemicals that create water-attracting and water-repelling areas in cell membranes and help to solubilise hydrocarbons that can then be used as a nutrient source. More recently, a study published in the pre-eminent journal "Nature" showed that humic substances interact with microbes to help them oxidize organic compounds anaerobically[17].

Concerns Addressed: Soil Health

Stimulation of microbe numbers and metabolism by humates can improve soil quality and texture and increase its cation exchange capacity. This improves the capability of soil to acts as a reservoir for nutrients and increases their availability to plants.

Humic Substances Improve Plant Growth

While the high fertility of humus-rich soils has been known for centuries, it is only relatively recently that scientist have examined the specific effects of humates on crop growth in field trials and pot experiments. A review of these studies tells us that humates can increase crop yields through better nutrient uptake in a wide variety of agricultural produce. Some examples are:

Humates can increase crop yields through better nutrient uptake in a wide variety of agricultural produce.

Wheat: Foliar application of fulvic acid

Humates prevented drought-induced yield reduction, increased phosphorous uptake and reduced water loss through the leaves when applied to wheat plants as a foliar spray. This study was published in the Australian Journal of Agriculture Research[18].

Potatoes: Application of humalite-derived substances

Potato crops were treated with liquid humate solutions added to the soil, or humate solids incorporated in mineral fertilizers. In the Journal of Plant Nutrition, total potato yield was reported to be increased by an average of 15% by these additives. Nitrogen and phosphorous uptake in to treated potatoes were higher than control crops with no humates[19].

Maize Seedlings: Addition of humates to hydroponic nutrient solutions

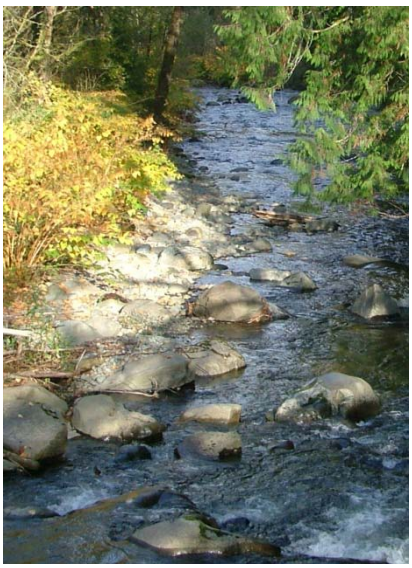
In this greenhouse test published in Bioresource Technology[20], agriculturalists found that while humates did not affect the percentage or rate of seed germination, root elongation was enhanced and the biomass of the roots, shoots and leaves of the maize plants was increased.

Turfgrass: Incorporation of granular humate into soil

Scientists from the Department of Crop Science at North Carolina State University[21] conducted a greenhouse experiment to determine the effect of humic substances on creeping bentgrass turf (*Agrostis stolonifera L*.). They incorporated a commercially available granular humate to a depth of 10 cm in sand culture and demonstrated a significant increase in root mass compared to cultures with no humates added: 45% at 0-10cm, and 38% at 10-20cm.

Similar increases in yield and nutrient incorporation have been reported when tomatoes, spinach, blueberries and grapes are given humate supplements.

All of this scientific evidence points to humates as excellent promoters of plant nutrient uptake and growth. They seem to do this by several mechanisms. In addition to better nitrogen fixation and improved cation exchange capacity of soil, humates also mimic the effects of naturally-occurring plant growth hormones called auxins[22]. Auxins (indole-acetic acids) promote root initiation, cell elongation and division and a host of other organizational functions in plants. Humates are exceedingly large, complex structures that are irreversibly bonded to many bioactive molecules and it has recently been shown that one of these bound ingredients is indole acetic acid that mimics the effects of endogenous plant auxins[23].



Concerns Addressed: Nitrite Pollution of Water Sources

One of the biggest current environmental concerns is pollution of ground and surface water by excess nitrogen, partly from leaching of excess mineral fertilizers[24]. While nitrogen contamination may come from a variety of sources, the contribution of inorganic fertilizers such as diammonium phosphate (DAP) and urea is a particular issue. Improved utilization of nutrients by plants could mean that less mineral fertilizers need to be added to give the same effect on yield.

There are three water quality concerns associated with nitrogen pollution[24]:

- Concentrations of nitrite above 10mgN/L are associated with methemoglobinemia ("Blue baby syndrome").
- Ammonia is directly toxic to fish.
- Elevated nitrogen levels promote excess growth and decomposition of nuisance algae, leading to reduced oxygen concentrations.

Clearly, any farming practise that reduces the amount of fertilizer use, or reduces leaching of nitrogen from soils into ground and surface water is beneficial to the environment. Humates increase the availability of applied nutrients to plants so that less fertilizer is needed, and also allow soil to retain more water, reducing runoff.

5. LIVESTOCK BENEFIT FROM HUMATES AS FOOD SUPPLEMENTS

Animal agriculture raises several environmental concerns including nutrient (nitrogen) pollution of both ground (drinking) water and surface water. Air quality issues (ammonia emissions) associated with animal agriculture may be deemed a public nuisance and ammonia has direct toxic effects on vegetation[25]. Farmers and researchers have tested humic substances as mineral sources and pH adjuster in animal feeds and looked at their effect on feed conversion efficiency and ammonia emissions.

Cattle: Faster growth to market specification

In a study published in the Australian Journal of Veterinary Medicine[26], feedlot cattle were given a commercial humic and fulvic acid complex as a dietary supplement (0.055g per kg body weight). Cattle receiving the supplement reached market specifications for body weight and fat depth in fewer mean

days and had a greater average daily weight gain and whiter fat compared with cattle who did not receive the supplement.

Pigs: Improved carcass quality

Dietary humic substances can affect the growth and carcass quality in pigs. In their study of various dietary humic substances each with different fulvic acid and humic acid contents, scientists from Texas Tech University demonstrated that pigs fed diets with 0.5% humic acid had greater average daily gains and gain to feed ratios than control pigs. Ammonia emission from manure was reduced in these same pigs by 18%[27].

Poultry: Increased body weight

Scientific evidence shows that the addition of humates as a dietary supplement in cattle, pigs and hens can increase feed conversion efficiency

Two recent studies have looked at the effect of dietary humate supplementation in hens on growth, carcass traits, meat quality and egg production. In the first report, humic substances were provided to broiler chicks at a variety of concentrations through their drinking water. A concentration of 1.0% was found to provide optimal increases in feed efficiency, body weight and carcass weight compared to birds that received no supplement[28]. In a second study on egg production, humate supplements did not increase egg quality but this study confirmed increased feed conversion efficiency[29].

While further study is needed to determine the best concentrations, scientific evidence shows that the addition of humates as a dietary supplement in cattle, pigs and hens can increase feed conversion efficiency.

Concerns Addressed: Meeting Increasing Demand

Humic substances added to the diet of livestock could form part of a solution to address the increasing global demand for livestock products; obviously, generating more product per animal is a better solution than simply increasing the number of animals. Improved feed conversion efficiency also means that less nitrogen consumed by the animal ends up in the environment.

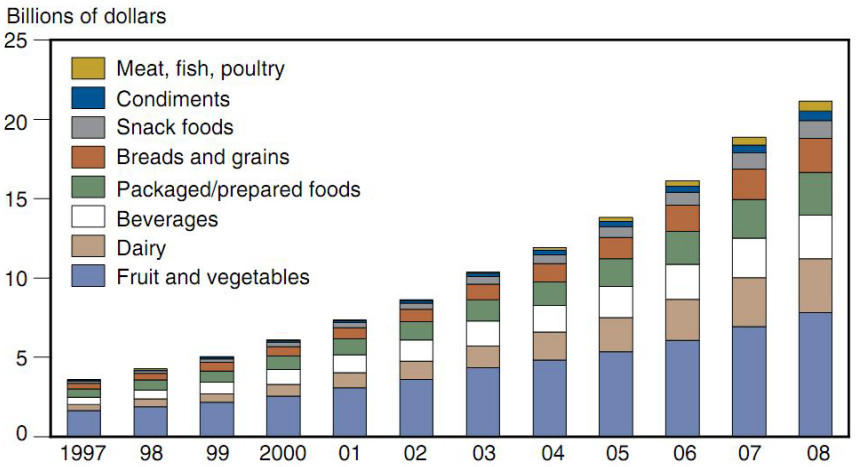
6. HUMATE PRODUCTS FIT INTO A VARIETY OF FARMING PRACTISES

Humates are commercially available in several formulations including liquids, powders and granules of several sizes. High quality powders, granules and dry soluble products will contain 80% or more organic matter (humin, humic acid and fulvic acids combined). Liquid formulations are available that contain humic acid or fulvic acid alone. Humate products can be used as organic

soil conditioners, foliar sprays, or in combination with fertilizers. The following sections provide guidelines and suggestions for trialling and incorporating humic substances into your farming practise.

Organic farming

Humates are 100% organic, and the increasing appetite for organic food in the United States is fuelling rapid market growth, as illustrated in the chart[5]. A more recent press release from the Organic Trade Association estimated the value of the U.S. organic industry at $29 billion in 2011[30]. Approximately 40% of the revenue from organic products is generated from the fresh produce sector and this has led to supply shortages in some instances. Consequently, organic farmers are under particular pressure to increase yields while rejecting unsustainable or harmful practises such as post-emergent harrowing for weed control and the application of herbicides.



Source: *Nutrition Business Journal*, 2009.

Clearly, humates offer a potential solution: they significantly increase yields from a wide variety of grains, fruits and vegetables while being safe for the environment.

Trialling Suggestion

High quality humic substances derived from humalite can be trialled as a stand-alone fertilizer at various rates from 0.5 to 50 kg/hectare. Mini-granule humate formulations have been tested and an application rate of 20kg/hectare was shown to produce a 27% yield increase from corn. Beneficial effects were seen with rates as low as 5kg/hectare with coal-derived humic substance products. 20kg/ha is the current recommended maximum for formulations containing 80% or higher organic matter[31]. Organic livestock and dairy farmers can also trial humate powders as a feed additive similar to conventional methods.

Agriculture and Horticulture

Humates have the unique capacity to bind nutrients in soil, making them more available for uptake by plants. They can be used as soil conditioners, fertilizer enhancers and foliar sprays.

Foliar Feeding versus Soil Application

Both foliar feeding and soil-applied humates will stimulate root growth and improve crop quality. In soils of low to moderate fertility, both methods can be used in combination. Foliar application of humic acid will preferentially reduce water losses through transpiration, but the concentrations applied are generally too low to affect soil quality. Soil-applied humates increase microbe activity, improve water retention and increase nutrient availability.

Trialling Suggestion

Mini-granule or powdered forms of humates can be applied in combination with diammonium phosphate (DAP) or urea. In combination with DAP, humic substances form a phosphate-humate that is available to crops throughout the plant cycle. This can be seen in leaf test comparisons where crops treated with humates maintain their phosphorous levels compared with a fall-off in phosphate in untreated crops. Similarly, when applied along with urea, humates prevent urea conversion to highly leachable nitrites and promote its uptake into roots. The expected result of such a trial would be increased yield and a reduced need for nitrogen fertilizer.

Cost Analysis Example: Corn

The following is a hypothetical cost analysis showing a potential increased profit margin when humic substances are applied along with DAP as a fertilizer for corn. While this is a hypothetical example, the numbers are based on real results from scientific testing of humates in field trials and greenhouse experiments.

Variables		
Cost of DAP based on past 4 yr average of $692/ton		$0.76/kg
Calculated fertilizer application rate (90kg N /ha)		275 kg DAP / ha
Average price of corn over past 6 months		$280/tonne
Assumptions		
DAP application rate reduction from use of humates		25%
Yield increase for corn using humates		10%
Costs per hectare:	275kg DAP at $0.76/kg	$208
	Humic product at 5kg/ha	$12
Yield per hectare:	Up from 8.5 to 9.4 tonnes/ha	$252
Cost Summary/ha:	Cost of humate application	$12
	Saving of 25% on DAP	$52
	Profit from 0.9 extra tonnes corn	$252

Net Gain = $292 per hectare.

Turf Growing

The aim of any turf growing operation is to produce high quality, uniformly dense sod that is free from serious weeds and thatch and has good colour and strength for handling. Development of a strong, well-knitted root mass is more important than the quality of the above ground portion. The critical issues for growing a high quality sod are:

- adequate contact of the seed with the soil
- good drainage
- mowing to encourage root growth and knitting (development of by above-ground rhizomes and below-ground stolons)
- nitrogen availability

Humates influence three of these four essential processes: soil texture (improved seed contact), drainage, and root mass knitting and strength through their hormone-like activity and increased nutrient uptake.

Trialling Suggestion

Humic substances formulated as powder and dry soluble products can be used as binding / coating agents for granular fertilizers or seeds in the fall. For post-emergent use, fine humate mini-granules are small enough to fall between the turf blades and can be applied along with fertilizers. In addition, liquid humates can be used as foliar sprays. The expected results of trialling humic substances on turfgrass would be better quality, stronger sod with a reduced need for fertilizer and irrigation.

Livestock Farming

Humates are beneficial as a dietary supplement in cattle, pigs and poultry. Shortened time to market, higher carcass weight, better gain to feed ratios and reduced ammonia emissions have all been shown to result from adding humic substances to livestock feed.

Trialling Suggestion: In the studies discussed, the most common way to use humates as a feed supplement was to add them to drinking water at a concentration of 1% by volume. The outcome of trials can be determined by comparison of standard variables such as carcass weight between animals that received the humate supplements and those that did not.

While profit margin volatility is forecast to be an ongoing issue in livestock farming [6], there is good evidence that humic substances have beneficial effects on feed conversion efficiency in livestock. This opportunity can be tested by individual farmers in their own practises

7. OUTLOOK

While there are many challenges related to the impact of agriculture on the environment, promoting increased yields using organic methods can be a cost-effective alternative or addition to conventional chemical-based practises. High quality mined humic substances are an underutilized but scientifically validated alternative for promoting soil health that can contribute to continued profitability.

8. ABOUT BLACK EARTH HUMIC LP

Black Earth Humic LP develops products and markets for high-grade reserves of Alberta humalite, a weathered type of sub-bituminous coal. Originally formed by Luscar Ltd. in 1998, Black Earth focusses on customer-oriented solutions underpinned by accredited scientific research. They develop, manufacture and distribute a range of high quality, competitively-priced humalite products with multiple applications in the agriculture / horticulture, environmental and industrial sectors. Black Earth Humic LP is headquartered in Edmonton, Alberta, Canada.

Agricultural Product Summary

A wide variety of dry and liquid products for agricultural applications are sold under the name Black Earth. These include powders, mini granules, organo-liquid hume and liquid fulvic formulations certified by the Organic Materials Review Institute in Eugene, Oregon. Custom product formulations are also available.

For more information, visit the Black Earth Humic LP website at http://www.blackearth.com or call 780-453-2100.

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