GLOBAL
ENVIRONMENTAL
INDUSTRIES PTY LTD

Earthmakers

Soil FoodWeb Labs

Global Environmental Industries

GLOBAL
ENVIRONMENTAL
INDUSTRIES PTY LTD

Earthmakers – Soil FoodWeb Labs

Biological Humus Production
Building Healthy Soil

Eliminating Synthetic Chemical Fertilizers/Raw Waste
Increase Soil Organic Carbon (SOC)
A sustainable solution to Global Warming

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Abbreviations

BRIX*	See attached definition
CO_2	Carbon dioxide
CO_{2E*}	Carbon dioxide equivalent (see attached derivation)
CH_4	Methane
NO_2	Nitrous Oxide
N	Nitrogen
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GHG	Greenhouse gas

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Abbreviations

GWP	Global Warming Potential
Ha	Hectare
GT	1 billion tonnes
ML	1 million litres
GL	1 billion litres
SOC	Soil Organic Carbon (58% SOM)
SOM	Soil Organic Matter
UNFCCC	United Nations Framework Convention on Climate Change

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Definitions

BRIX Index

Within a given species of plant, the plant with the higher refractive index will have a higher sugar content, higher mineral content, higher protein content, and a greater specific gravity or density. This results in sweeter tasting, more nutritious food with lower nitrate and free-water content, and better storage characteristics.

With better nutrition, the higher sugar content, and less mineral stress, resistance to insects is greater, thus resulting in decreased insecticide usage.
Crops with a high sugar content will have a lower freezing point, and therefore be less prone to frost damage.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Definitions

CO_2 Equivalent

A gas's contribution to the greenhouse effect depends not only on its capacity to absorb and re-emit radiation, but also on its *residency time* in the atmosphere — how long it remains there in that molecular form. Gas molecules gradually break down or react with other atmospheric compounds to form new molecules with different radiative properties.

Methane has an average residency time of about 12 years; nitrous oxide, 130 years; and carbon dioxide, 100 years. Over a 20-year period, 1 kilogram of methane has 56 times greater ability to trap radiation than 1 kilogram of carbon dioxide.

Definitions

CO_2 Equivalent

But, over time, the action of sunlight (energy) breaks methane into carbon dioxide and water. So, over 100 years, methane has a global warming potential 21 times that of carbon dioxide. Similarly, nitrous oxide is 310 times more effective than carbon dioxide over a 100-year span.

These two figures — 21 for methane and 310 for nitrous oxide — are called *global warming potentials* and are used to weight the effectiveness of these two gases in the calculation of the greenhouse gas budget. In other words, emission values for methane and nitrous oxide are expressed as carbon dioxide equivalents.

Definitions

CO_2 Equivalent

The total carbon dioxide equivalent (measured in megatonnes) of the emissions of nitrous oxide, methane, and carbon dioxide is calculated as

CO_{2eq} = (N_2O x 310) + (CH_4 x 21) + (CO_2 x 1).

The global warming potential, a tool developed mainly for policy makers, provides a simple measure to compare the potency of various greenhouse gases in carbon dioxide equivalent units. This comparison is useful when a decision must be made on which gas emissions should be reduced and what mitigation options are best. For example, a small reduction in nitrous oxide emission can be just as effective as a larger reduction in carbon dioxide emission. In this report, global warming potentials are based on a 100-year time horizon.

R.L. Desjardins, Agriculture and Agri-Food Canada

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Definitions

Soil Organic Matter – Humus and the Soil Food Web

Organic matter and humus are terms that describe somewhat different but related things

Organic matter refers to the organic fraction of the soil that is composed of both living organisms and once living residues in various stages of decomposition. Humus is, under normal conditions, only a small portion of this. It is the end product of organic matter decomposition and is relatively stable. Humus contributes to well structured soil and in turn produces high quality plants.

Earthmovers and Soil Food Web formulate biology to convert organic matter to stable humus within 2 years.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Definitions

Carbon Dioxide Sequestration

Sequestration is the removal of carbon dioxide from the atmosphere by enhancing natural absorption processes in vegetation and soils. In this case carbon sequestration is achieved by using biology to restore the earths natural ecosystems. The biology is formulated (using the subject soil as a catalyst) that store carbon.

There are ideal ratios for certain key soil organisms in highly productive soils. Soil microbial community is formulated to suit soil – crop – climate and can be enhanced to produce stable humus and store carbon to a selected level.

Carbon sequestration is measured by measuring the initial carbon content of the subject soil compared to the measured increase, on an annual basis. Soil organic carbon is measured in tonnes as a percentage of the soil per hectare to a depth determined by the crop root based on the bulk density of the soil.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Definitions

CO_2 Measured in ‘C Equivalent’

Only the mass of the carbon is measured, not the mass of the carbon di-oxide. This is a scientific convention accounting for the fact that carbon cycles through the air, oceans, biosphere, fuels, etc, and in the process occurs together with different elements (eg. CO_2, CO, CH_4, $CaCO_3$, CFC-12). Emissions expressed in units of elemental C can easily be converted to emissions in CO_2 units by adjusting for the mass of the attached oxygen atoms, that is by multiplying by the ratios of their molecular weight (44/12 or 3.67)

NO_x measured in ‘N equivalents’ follows the same logic.

Source: www.ucsusa.org/global_environment

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Definitions

Nitrogen Fixing

Nitrogen is predominantly in the atmosphere as nitrogen gas. The trick is getting that nitrogen into a form that plants can use. Most of the nitrogen fixed is by micro organisms.

All N fixation requires the help of bacterial enzymes. Commonly known are N fixing bacterial genus, rhizobium on the roots of legumes.

There are other abundant N fixing bacteria. Cyanobacteria form filaments and are typically photosynthetic. The bacterial fixing their own carbon from carbon dioxide also fix nitrogen inside those filaments.

Free living nitrogen fixing bacteria such as azotobacteria and zospiriclium, also fix N in the roots of many plants. The plant supplies the sugars in the amount required for these bacteria to perform nitrogen fixing.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

UNFCCC Guidelines

- Empirical data for NO_2 emissions due to application rates of N fertilizer have been shown to be higher than the UNFCCC emissions factor
- The document is designed to be interactive and can be adjusted to suit specific data
- We have not taken into account in our summary other factors such as energy to produce pesticide and herbicide, energy for spreading, leaching of runoff to waterways, and N being absorbed from the atmosphere. The specific data can be added for each individual area
- To calculate these figures accurately, use the formulae from the UNFCCC guidelines for NO_2 emissions, and/or data from country national inventories and empirical data where available

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Protocols

Soil – Conventional farming utilising modified management practices to reduce emissions

The complexity of monitoring and verifying GHG reductions using UNFCCC guidelines is such that it is debatable whether such reductions will be permissible.

However elimination of chemical fertilisers by using humus biology increases soil organic carbon which is measurable and verifiable.

The emissions saving from the use of chemical fertilisers is insignificant compared with the soil sequestration savings and will allow the UNFCCC to include soil GHG reductions due to empirical testing of the carbon content of the soil.

Our intention is not to account for GHG emissions reductions from the use of chemical fertilisers to simplify the accounting system, by measuring soil carbon content only.

Part A
Agriculture
A sustainable solution to global warming

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Mission Statement

To replace chemical fertilisers as the nutrient for food crops with biology formulated to establish the earths natural ecosystems with the ability to:

- Grow healthier more abundant crops
- Retain moisture to increase drought resistance
- Produce crops in third world countries at affordable cost
- Fix nitrogen absorbed from the atmosphere
- Reduce water vapour emissions from agricultural soils by a minimum of 80%
- Sequester carbon dioxide from the atmosphere sufficient to reverse global warming

GLOBAL
ENVIRONMENTAL
INDUSTRIES PTY LTD

Summary

Currently agricultural crop land management systems are a source of greenhouse gas emissions.

Management systems substantially utilise synthetic chemical fertilisers as nutrient for crop growth.

This practice depletes the soil of its natural ecosystems. The chemical reaction in the soil creates the climate for microbial decay and hardening of the soil, reducing the soils ability to retain water. Thus creating conditions which is susceptible to erosion and less resistant to drought.

Soil organic carbon has been reduced world wide to less than 2%.

Healthier more abundant crops can be grown without the use of chemical fertilisers. Biology can be formulated to establish the soils natural ecosystems. The healthier soil retains water, minimising erosion and creating conditions which can sequester and store carbon.

The biology systems can be introduced and implemented in the next growing season with immediate results.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Summary

The biology is formulated to suit soil, climate and crop type. The biology cost to grow crops and reduce water required is on par with current fertiliser programs.

The biology can also be formulated to increase soil carbon within soil by up to 15%. This requires a higher application rate and is realised within 5 years.

At a bulk density of 1.288kg/m^3 carbon dioxide sequestration per hectare in 5 years equated to 2,129 tonnes. We intend to limit the increase to approximate emissions reduction required over the next 20 years.

The increased cost can be offset by carbon credit trading. This would give farmers the necessary incentive to increase carbon to the desired level.

The increase in carbon is measurable and verifiable.

The water reduction realised of itself is sufficiently compelling to change to humus production management practices.

The carbon sequestration linked to a carbon credit scheme provides a solution to global warming and a sustainable rural sector.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Summary

Soil FoodWeb Labs and Earthmakers Australia have produced the biology to:

- Build healthy soil
- Produce stable humus providing the catalyst to sequester carbon dioxide (CO_2) and fix nitrogen in agricultural soils in sufficient quantities to meet or exceed specific Kyoto emissions targets
- Eliminate the use of synthetic fertilizers, herbicides and pesticides in agricultural practices
- Establish humus rich soil
- Eliminate tillage and soil erosion
- Eliminate the use of raw waste products as fertilizer and their disease carrying potential
- Reduce irrigation requirements by up to 60% due to the water retention properties of humus rich healthy soil
- Increase SOM (soil organic matter) to a selected sustainable level up to 25%

Summary

Commercial contracts can be designed between technology providers, growers and government to:

- Implement sustainable agriculture
- Meet GHG targets
- Provide secure future for rural sector
- Reverse global warming
- Amortise the carbon dioxide sequestration over 20 years to:
  - Ensure farmers continue to grow crops for that period
  - To maintain reductions in line with emissions
- Carbon credits are envisaged to be paid annually

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Part B
Global GHG Emission Implications

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Global GHG Emission Implications

The Stern Review – Economics of climate change identifies

Global warming as the greatest threat to providing global equity in living standards, food production, health and water supply.

It also provides an insight into the consequences of business as usual (BAU) emissions and the reductions required to avoid unacceptable global warming.

BAU – GHG Emissions – Carbon Dioxide equivalent CO_{2E} GT / annum

- 2010 – 45,000 GT / annum
- 2035 – 65,000 GT / annum
- 2050 – 85,000 GT / annum

The recommended sustainable emission level is put at approx. 20,000GT.

The next 20 years is critical to avoid an unacceptable CO_2 concentration build up in the atmosphere.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Global GHG Emission Implications

The Stern Review – Economics of climate change identifies

Measures to reduce emissions such as reforestation, technological advancement, etc, have lengthy implementation periods and renewable energy of itself is not sufficient to offset the predicted increases.

Agricultural crop lands have the ability to reduce global warming within the 20 year critical period, giving time for other strategies to catch up.

An average of 2,000 tonnes of CO_2 per hectare can be sequestered in the first 5 years from the time of implementation.

This equates to an average of 100T CO_2 / Ha / annum amortized over 20 years.

Implementation time is constrained by the will to change. Farm practices can be changed for the next growing season progressively increasing carbon capture each year.

Current farm practices have depleted soil organic carbon to less than 2% globally.

Farm practices using biology formulated to suit soil – crop and climate builds healthy and stable humus soil which has the ability to increase soil carbon by up to 15% over a five year period and is sustained thereafter.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Global GHG Emission Implications

CO_2 sequestered from the atmosphere is measurable based on soil initial conditions and bulk density.

The sequestered SOC can be based on implementation time and economics.

The higher the SOC level the less Ha required.

The crop land required to reduce emissions from the estimated 65,000 GT / annum by 2035 to the recommended 20,000 GT / annum is shown in table 1.

Table 1 - CO_2 Sequestration - Soil Carbon Increase

	Area (Ha)	CO2 @ 5%	CO2 @ 15%
China	99,000	3.30	9.90
India	140,000	4.67	14.00
USA	167,000	5.57	16.70
Russia	48,000	1.60	4.80
Georgia	42,000	1.40	4.20
Canada	35,000	1.17	3.50
Australia	26,000	0.87	2.60
Total	***557,000***	***18.58***	***55.70***
Other	707,000	23.57	70.70

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Global GHG Emission Implications

CO_2 sequestration (GT) is based on 1% initial carbon content and a bulk density of 1.288 kg / m^3.

1 billion hectares @ 5% SOC would be required to reduce emissions to 20 billion tonnes / annum.

Selecting 480 million hectares of crop land from around the world @ 15% SOC would meet the Stern Report recommended reductions to 20 billion tonnes / annum based on present world emission increases in the next 20 – 25 years and would provide an increased financial incentive from carbon credit trading for farmers to implement the process.

Carbon credit trading provides the third world with self funding for food production.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia
GHG Emissions – Kyoto Compliance

Kyoto Target	108% of 1990 emissions (MT CO_{2E})	
1990 emissions	552	
Kyoto Target	596	

Predicted emissions (BAU) Business as usual and with reduction measures

	BAU	With Measures
2010	690	603
2020	837	702

Best case with measures, reduction required by 2020 to meet target (702-596) 106MT

Australia crop land 26M Ha

Ha required to meet reduction target:

SOC Increase	Ha (x 1,000)
5%	12,848
15%	1,060

Increasing SOC to 5% has a comparable cost to conventional fertiliser systems with the advantage of higher yield (min. 10%), reduced water requirements (min. 30%), healthier crops (higher BRIX), and within 2 years, organic certification commanding higher prices.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia
GHG Emissions – Kyoto Compliance

Increasing SOC to 15% would require farmer incentives. Australia is embarking on developing its own carbon trading scheme.

This strategy provides the flexibility to consider joining the European Union Trading Scheme, avoiding a significant cost.

The higher the carbon price the more secure would be the rural sector.

Allowing farmers to tap into the world market gives the total industry the opportunity to grow crops and carbon.

Note: We intent to limit the supply of biology to food production, except in cases where the Government agrees to remediate land for environmental purposes.

To expedite the process given the 20 year time frame we would select 1,000,000Ha based on economic viability and water requirement to meet the Kyoto target.

(Concurrently areas would be selected based on water reticulation considerations to increase SOC to 5%. Farmers can then select to increase SOC further)

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia
GHG Emissions – Kyoto Compliance

Additional Benefits

As carbon increases soil structure has the capacity to retain moisture.

Water requirements are reduced by a minimum of 30% equivalent to a reduced rainfall of 110mm in a 360mm average rain fall area in year 1.

As the natural ecosystems grow, moisture holding capacity increases providing a more drought resistant environment.

Crops are healthier (higher BRIX)

Crop yield is increased by a minimum of 10%.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia - Water Implications

Australian Irrigation Use GL / annum

NSW	3717
VIC	2364
QLD	2613
SA	877
WA	267
TAS	232
NT	14
Total	10,100

The soil organic matter content is related to moisture holding capacity.

Australia's soils currently have an average of 1% SOM

Biology can increase SOM by up to 25%.

Water holding capacity of 1 hectare 300mm depth @ 25% SOM level increases from 180,000L @ 1% to 1,350,000L @ 25%.

Irrigation requirement after year 1 can be progressively reduced from a minimum of 30% by up to 60% - 70%

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia - Water Implications

Water Implications Summary

Irrigation savings

Min 3000GL @ 5% SOC

Max 7000GL @ 15% SOC

Note: Increase SOM from 1% to 25% is approx 5 years, water saving would progressively increase over that period to maximum level

Farmers with increased SOM will benefit from reduced water costs and less reliance on allocations.

Environmental flow would be increased accordingly.

Crops grown in low rainfall areas will have a minimised risk of failure due to lower than average rainfall.

Once the natural ecosystems are established, rainfall could be 50% below average with no detrimental effect on current yield levels.

Given Australia's river murray critical condition the adoption of biological humus crop production is in the interest of farmers, government and the environment.

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia - Implementation Strategy

Summary

Farmers change over cost	$180,000
Minimum farm size	1,000Ha
Loan cost (20 years) @ 10%	$15,300 / annum
Cost loan/Ha/pa	$15
Cost of Biology/Ha	$400
Sacrificial Crop/Ha	$30
Total Cost/Ha pa	***$445***

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Australia - Implementation Strategy

Summary

Table 2 - Indicative Net Cost Benefits to Farmers to Increase SOC Levels vs Conventional Practices

Crop 25% SOM	Cost Conv./Ha	Cost of Biology ($/Ha pa)	Carbon Credit ($/Ha)	Yield +10% Income	Water Saving (50%)	Yield +30% Income	Additional Income ($/ha) (Ex. Yield Inc.)	Share Carbon Credit	Area (Ha) (1,000's)	Water Use (ML pa)
Sugarcane	$1,100	$445	$300	$100	$130	$300	$1,130	30%	413	1,116
Cotton	$1,000	$445	$300	$167	$170	$500	$1,070	30%	124	857
Irrigated Crops	$550	$445	$500	$27	$130	$80	$780	30%	122	647
Wheat SA	$160	$445	$800	$20	$0	$0	$520	50%		-

Notes:

SOM = Soil Organic Matter

SOC = 58% of SOM

Cost includes fertiliser, herbicide, fungicide, plus other chemical where applicable

CO_{2E} tonnes per hectare @ 25% = 98

Grower receives share in carbon credits apropriate to economic viability

Water saving based on 50% reduction in use @ $50/mL

GLOBAL ENVIRONMENTAL INDUSTRIES PTY LTD

Summary

- The strategy is self funding using carbon credits. In some cases carbon credits to the grower are not required, since biology is more economical than conventional when crop yield increase is taken into account
- The carbon reductions from the increase in SOC and elimination of chemical fertilizers for specific crops is sufficient for countries to meet its emissions targets without the risk of funding technologies which are not proven
- Countries can then manipulate the agriculture sector to accommodate carbon credit trading responsibly linked to environmental balance and expediency
- Countries would have the ability to join the European Union Trading Scheme, eliminating the cost of developing its own trading scheme, and mitigating the risk of the cost to industry due to a non-capped system
- Countries could elect to take a lead role by exceeding targets and ***reversing global warming*** to allow other states/countries to respond

Protocol

The purpose of the protocol is to provide the necessary framework to quantify and subsequently certify the attributes of using biology humus production. The certification process will be simplified compared to protocols being developed for GHG emissions reductions achieved by conservation practices such as no till – organic farming, reducing but not eliminating chemical use.

The method has two major parts

Part one is aimed at the enterprise level with individual farmers establishing a baseline for their perspective farming operations from which the biology humus production performance will be measured.

Although emissions due to chemical fertilizer use are significant they are diminished by the sequestration ability of the enhanced ecosystem.

GLOBAL
ENVIRONMENTAL
INDUSTRIES PTY LTD

Protocol

The reporting systems will be simplified by measurement of the SOC increase only.

Reduction due to the elimination of chemical fertiliser application could be estimated at a conservative amount for reporting purposes or ignored in the scheme of things.

Part 2 will involve contracts between technology provider and farmer to use the land for its current purpose for a 20 year period renewable.

Verification will be carried out by a UNFCCC appointee.