Climate Change and GROW BIOINTENSIVE®

Perspectives from Ecology Action

"... don't treat climate and environmental energy issues as something that's completely separate from poverty reduction and millennium development goals. If you totally undermine the very basis of life on the one planet we've got to live on, then we'll never have sustainable development."
-Helen Clark, Chief Administrator of the UNDP

Climate Change: Cause and Effect

The planet is getting warmer.

Over the past 200 years, since the beginning of the industrial age, we have been burning fossil fuels, cutting down trees and producing livestock at unprecedented rates. As a result, the levels of greenhouse gases – such as carbon dioxide, methane and nitrous oxide – in the atmosphere have increased dramatically from preindustrial levels. These greenhouses gases trap solar radiation, just like the glass panes in a greenhouse, and warm the planet. This is good to some extent, since that warmth allows life as we know it to flourish. But, as the level of greenhouse gases gets higher and higher, more and more solar radiation is trapped and the temperature of the planet increases to levels we have never experienced. The average surface temperature for September 2015 was the highest in the 136-year record, more than 0.9°C above the 20th century average.[1] Based on 2014 data from NASA, 2014 was the warmest year, and the 10 warmest years on record all have occurred since 2000, with the exception of 1998.[2] The September global surface temperature has been increasing at an average rate of 0.06°C (0.11°F) per decade.[1]

- As temperatures get hotter, crop yields generally decline, as crops are not designed to thrive under these conditions.
- Rainfall patterns shift, causing more droughts, flooding and other catastrophic weather-related events, which will lead to regional food shortages and famine.
- Finally, with increased temperature, polar ice caps begin melting, causing dramatic rises in sea levels, flooding of coastal cities, loss of land through erosion, salinization and contamination of drinking waters and soils.

So what does this mean to human health? While it is challenging to precisely measure the health effects attributable to climate change, each of these events has significant negative consequences. Combined together, these effects become catastrophic on an unprecedented global scale that threatens life as we know it. A recent WHO study determined that 250,000 additional and unnecessary deaths will likely occur between 2030 and 2050 due to climate change. This study only included a subset of possible health impacts and assumed optimistically that there would be continued global economic growth and progress in human health.[3]

Agriculture and Climate Change: Problems and Solutions

So, we can feel overwhelmed. But then we ask: what can we do? Some people – increasingly few these days – respond by saying that this type of warming is just a natural cycle, that our activities like burning fossil fuels, deforestation and livestock production have nothing to do with it, and that there is not much we can do about it anyway.

But as farmers and gardeners, we know there is something we can do – but it is not simply to continue farming as most of us do, because it turns out that *our current methods of farming are actually a large part of the problem*.

- 26% of the ice-free land on Earth is for grazing livestock, and 33% percent of cropland is used for livestock feed production.[4]
- Livestock production emits 7.1 GT (gigatons) of carbon dioxide equivalents per year, about 14% of the total annual human-induced greenhouse gas emission carbon dioxide emissions.[5]
- Livestock generates 65% of human-related nitrous oxide and 35% of methane, which have 296 times and 23 times respectively the Global Warming Potential (GWP) of carbon dioxide.[6]
- Changes in land use, typically due to the cutting and burning of forests to grow more crops or cattle, emits 2.8 GT of carbon dioxide equivalents per year.[7]
- Finally, 74% of US nitrous oxide emissions (one of the most heat-trapping of the greenhouse gases) in 2013 are from the use of synthetic nitrogen fertilizer.[8]

We as farmers and gardeners know that plants take in carbon dioxide from the air and use the carbon to form their stems, leaves, roots and flowers. When the plant is harvested, we can put that carbon into the soil. So, if we farm in a way that maximizes the amount of carbon captured in our crops, and we return as much of that carbon as possible to the soil, we can effectively remove carbon dioxide from the atmosphere and store it in the soil.

In 2013, the amount of carbon dioxide in the atmosphere surpassed 400 parts per million, higher than any time in the last 400,000 years.[9] This level is expected to reach 550-1200 or more parts per million by 2100.[10,11] Prior to industrialization, there was only 270 parts per million of carbon dioxide in the atmosphere. In January of 2010, NASA climate scientist Dr. James Hansen proposed the target of 350 parts per million in order to stabilize the climate.[12] This may be too modest a goal, but if we consider it a good first step, how can we achieve this?

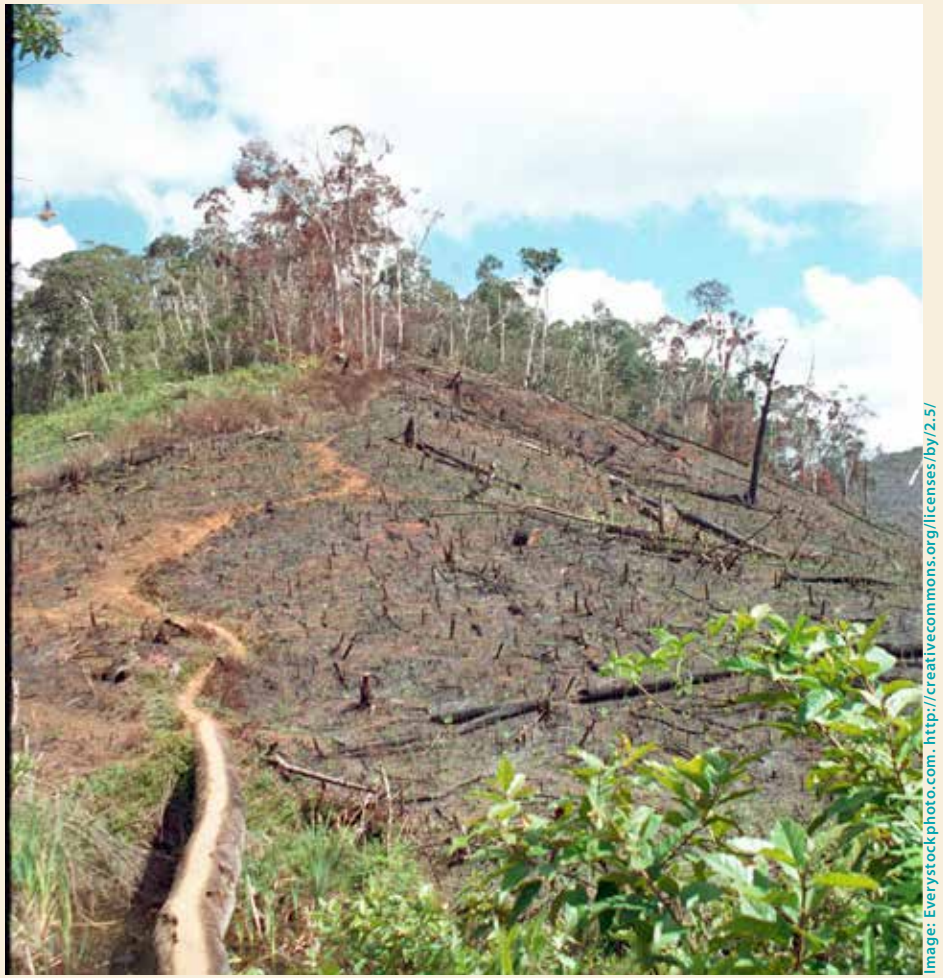

Image: Everystockphoto.com. http://creativecommons.org/licenses/by/2.5/

"During the last 50 years... availability of natural resources has shrunk faster than at any other time in history ...This has been compounded by a range of factors including... unprecedented loss of biodiversity, deforestation, loss of soil health, and water and air quality."

-IAASTD (2009) Agriculture at a Crossroads: A Global Report

"Organic farming leads to many improvements to the natural environment, including increased water retention in soils, improvements in the water-table ... reduced soil erosion combined with improved organic matter in soils, leading to better carbon sequestration and increased agro-biodiversity."

-UNEP-UNCTAD:
Organic Agricuture and Food Security in Africa

Biointensive Solutions to Global Challenges

We must first change the way we farm.

Our current food system is responsible for 19%–29% of global greenhouse gas (GHG) emissions attributable to humans.[13] Conventional intensive tillage and conventional fertilizer usage need to be minimized. Livestock production needs to be minimized. We must increase our crop production on our currently available agricultural land, and reduce or halt deforestation. How can we do these things and still feed ourselves and our growing population? GROW BIOINTENSIVE® offers some real solutions here.

- GROW BIOINTENSIVE® is a complete food growing system that requires no fossil fuels, and uses simple people-powered tools, and open-pollinated seeds, making it a system that anyone on the planet can use. It has been successfully used in over 140 countries for more than four decades, and much longer in some cases.
- GROW BIOINTENSIVE® food production uses close-spacing, farm-produced compost, double-digging as needed for cultivation, and minimal inputs of organic fertilizers to balance the soil's nutrients.
- With GROW BIOINTENSIVE®, we can produce 2 to 4 times the yields in the same area because GROW BIOINTENSIVE® –managed soil can support 4 times as many plants per unit of area.
- GROW BIOINTENSIVE® techniques have demonstrated energy production efficiency. Research in onion production indicated an energy efficiency ratio of 51.0, meaning for every calorie expended from direct and embodied energy, 51 calories were produced.[14] In US mechanized agriculture, onion production has an efficiency ratio of 0.9.[14] Similar work in flour corn showed GROW BIOINTENSIVE® to be 16 times more energy efficient than conventional production. Much of the energy used in GROW BIOINTENSIVE® is renewable. This combination of renewable energy, and dramatic energy-use reduction through efficiency, results in a significant reduction of greenhouse gases and the global warming they cause.

Biointensive Compost and Carbon Sequestration

This means more food is produced, to offset losses from increased temperature and other weather-related causes. It also means that our currently used farmland can be much more productive and we do not need to cut down forests in order to produce more food.

Also, GROW BIOINTENSIVE® encourages each farm to grow its own compost crops, in order to generate its own compost material to maintain the organic matter levels and fertility of its soil. Since compost crops are often taller, larger plants that capture more carbon dioxide, growing them increases the amount of carbon captured from the air and stored in the soil. In addition, with up to four times more carbon-rich crops per unit of area, much more carbon is removed from the atmosphere with GROW BIOINTENSIVE® compared to current agricultural practices. In fact, a preliminary study has shown that with GROW BIOINTENSIVE® up to 5 Mg (megagrams or metric tons) of carbon can be accumulated in the soil per hectare per year. If this method or similar method were applied to all of the arable and permanent cropland in world,[15] then 7.8 GT (gigatons) of carbon per year can be taken from the atmosphere and stored in the soil.

While GROW BIOINTENSIVE® can be used for sustainable livestock production, its focus is on creating nutritionally complete diets primarily from grain, legume, vegetable and root crops in order to minimize the total area needed to feed ourselves. So, instead of feeding the straw to livestock, and generating more methane, it can be returned to the soil. Most of the carbon that is returned to the soil as compost or as crop residues does not stay in the soil for more than a few years, but a small amount will stay for decades or longer. This means that growing compost crops and adding compost to the soil is not a one-time solution if we want to reduce carbon dioxide levels year after year. Instead, we as farmers and gardeners need to grow compost crops and return as much carbon to the soil as possible every year or more often in warmer climates in order to continually keep the carbon in the soil and out of the atmosphere.

Finally, GROW BIOINTENSIVE® does not require the use of fossil fuels, so its widespread use would greatly reduce the amount of carbon dioxide being emitted by agriculture into the atmosphere.

"Agricultural carbon sequestration has the potential to substantially mitigate global warming impacts ... practical organic agriculture, if practiced on the planet's 3.5 billion tillable acres, could sequester nearly 40 percent of current CO_2 emissions."

-Rodale Institute (2008) Regenerative Organic Farming:A Solution to Global Warming

"Climate change will affect the four main elements of food security – availability, stability, utilization and access.... The next stages in agricultural development will need to be ...about conserving natural resources, recycling carbon and ensuring that soils retain vital nutrients."
- UN-ESCAP: Agriculture and Food Security, Asia/Pacific

We Can Change the World

The level of atmospheric carbon alone increases by roughly 4.26 gigatonnes (equivalent to about 2 ppm of carbon dioxide by volume) annually.[16,17] In order to reduce the atmospheric carbon dioxide level to about 350 parts per million, as proposed by Dr. Hansen and others,[18] what would we need to do?

Use GROW BIOINTENSIVE® to reduce CO_2 emissions

19 to 29% of all carbon dioxide emissions are attributable to our food production system However, as we have illustrated here, GROW BIOINTENSIVE® uses much less energy compared with conventional agriculture and as little as 1% to 6% of the fossil fuel compared to consumption rates of conventional agriculture. Widespread use of GROW BIOINTENSIVE® may be able to reduce the agricultural carbon dioxide emission rate to as low as 5% or less, reducing the annual carbon dioxide emissions to slightly over 1 ppm.

Use GROW BIOINTENSIVE® to store carbon in the soil

Widespread use of GROW BIOINTENSIVE® may be able to store 7.8 GT of carbon in the soil per year, or a net gain of 3.5 GT per year (assuming the rate of carbon dioxide additions remains at 2 ppm per year which may be possible with the conversion to GROW BIOINTENSIVE® as described above). Then, after about 31 years of concerted effort, approximately 107 Gt C (50 ppm CO_2) could be captured from the atmosphere, which would increase the organic matter content of soils by approximately 13.5%. With focused, committed effort and the conversion to GROW BIOINTENSIVE®, in approximately 31 years we could decrease the atmospheric carbon to about 350 ppm - the amount recommended by Dr. Hansen and considered by many climatologists as a safe level of atmospheric CO_2.[18]

With each of us doing a small part, managing our forests well, and adopting methods like GROW BIOINTENSIVE® to reduce the need for reforestation and the use of fossil fuels in agriculture, we can help reduce carbon dioxide emissions, store carbon, and alleviate negative environmental effects. Working together, we can use the tools available to us right now to avert one of the greatest challenges humankind, and in fact, all life on the planet is facing.

References

1 Global Analysis – September 2015, https://www.ncdc.noaa.gov/sotc/global/201509, accessed 11/9/15.

2 Global Climate Change: Vital Signs of the Planet, http://climate.nasa.gov/vital-signs/global-temperature/, accessed 11/9/15.

3 Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. Geneva: World Health Organization, 2014.

4 Livestock and Landscape, FAO, 2012, http://www.fao.org/docrep/018/ar591e/ar591e.pdf, accessed 11/10/15

5 Tackling Climate Change Through Livestock, FAO, Rome 2013

6 The Role of Livestock in Climate Change, FAO, http://www.fao.org/agriculture/lead/themes0/climate/en/, accessed 11/10/15

7 FAOSTAT, http://faostat3.fao.org/browse/G2/*/E, accessed 11/10/15

8 Overview of Greenhouse Gases- Nitrous Oxide Emissions, US EPA, http://www3.epa.gov/climatechange/ghgemissions/gases/n2o.html, accessed 11/10/15

9 The relentless rise in carbon dioxide, http://climate.nasa.gov/climate_resources/24/, accessed 11/10/15.

10 IPCC, 2014, http://www.ipcc-data.org/observ/ddc_co2.html, accessed 11/12/15

11 US EPA, http://www3.epa.gov/climatechange/science/future.html, accessed 11/12/15

12 Target Atmospheric CO2: Where Should Humanity Aim?, James Hansen et al., Columbia University, http://www.columbia.edu/~jeh1/2008/TargetCO2_20080407.pdf, accessed 12/1/15

13 Vermeulen, S.J. et al., Climate Change and Food Systems, Annu. Rev. Environ. Resour. 2012. 37:195–222.

14 Moore, S. 2010. Energy efficiency in small-scale Bioin¬tensive organic onion production in Pennsylvania, USA. Renewable Agriculture and Food Systems: 25(3); 181–188.

15 Total arable and permanent crop land in the world was 1,572,504,570 hectares in 2013, FAOSTAT, http://faostat3.fao.org/browse/R/RL/E, accessed 12/1/15.

16 Trends in atmospheric carbon dioxide, http://www.esrl.noaa.gov/gmd/ccgg/trends/, accessed 12/1/15.

17 Carbon dioxide Information Analysis Center, http://cdiac.ornl.gov/pns/faq.html, accessed 12/1/15.

18 A safe operating space for humanity, Nature 461, 472-475 (24 September 2009) doi:10.1038/461472a; Published online 23 September 2009.

Author: John Beeby , with contributions from Steve Moore

Graphic Design: Shannon Joyner .

How Plants Store Carbon in the Soil

Plants form a "carbon highway" from atmosphere to soil, and this process of turning air into soil has four stages:

1. Photosynthesis, the process by which plant leaves use the sun's energy to absorb carbon dioxide and separate the carbon and oxygen to form sugars.

2. Re-synthesis occurs inside the plant, where the sugars are transformed into more stable carbon compounds.

3. Exudation and the release of organic matter happen when plants exude carbon into the soil through their roots, and when leaf, stem and root matter enters the soil through the natural life-cycle and/or composting processes.

4. Humification takes place when soil microbes decompose plant carbon into a more stable form (humus).

Adapted from: *Climate-friendly Farming* by Mukti Mitchell in the Nov/Dec 2009 issue of *Resurgence Magazine*

"...sustainable agriculture can produce enough food for the present global population, and eventually an even larger population, without increasing the area spared for agriculture."

-IAASTD (2009) Agriculture at a Crossroads: A Global Report

Ecology Action has been a small 501(c)(3) nonprofit organization since 1972.

Ecology Action
5798 Ridgewood Road
Willits, California 95490

www.growbiointensive.org
www.biointensive.net.

USA: (707) 459-0150
fax: (707) 459-5409