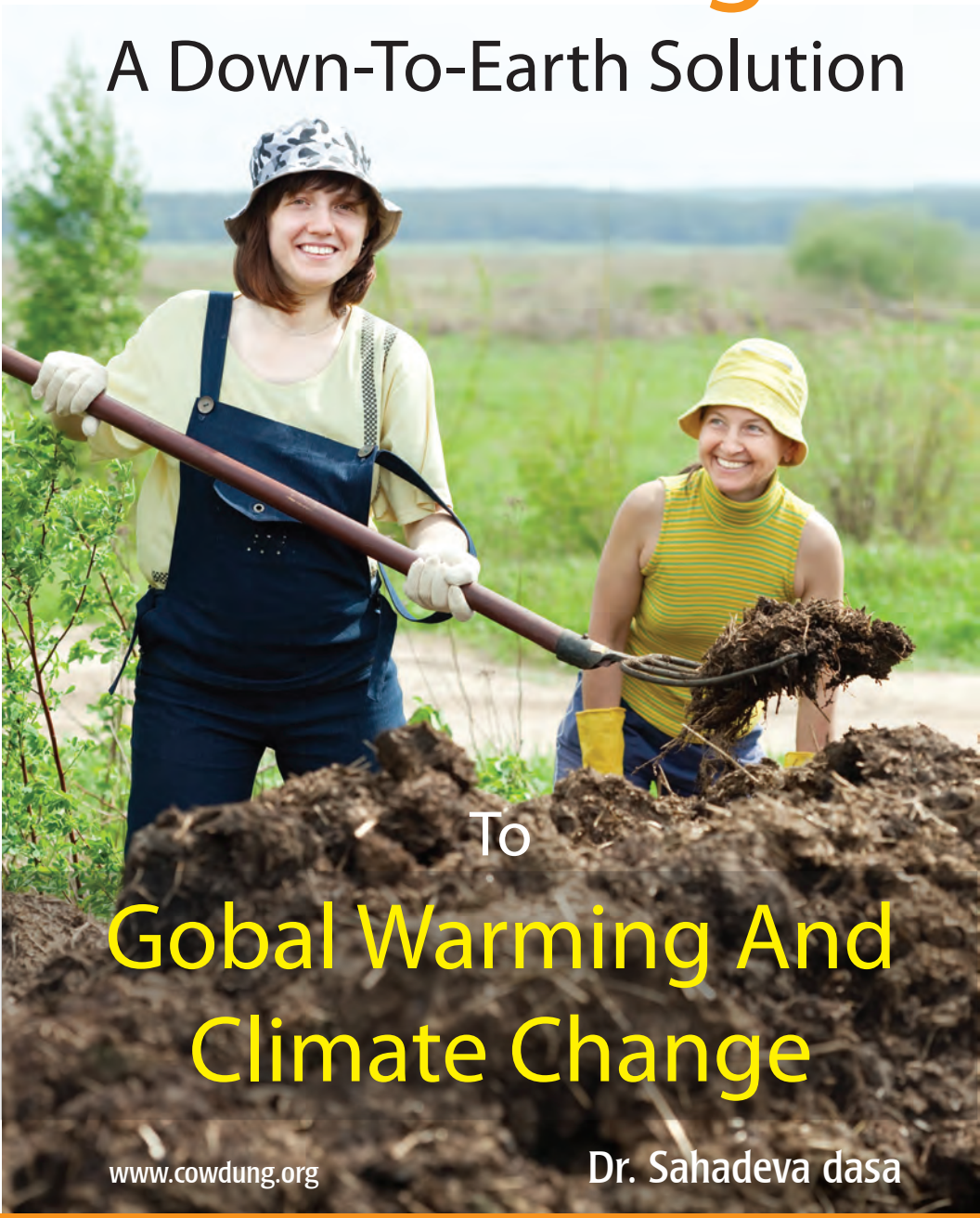
Cow Dung

A Down-To-Earth Solution



To

Gobal Warming And Climate Change

www.cowdung.org

Dr. Sahadeva dasa

Cow Dung

A Down-To-Earth Solution To Gobal Warming And Climate Change

By
Dr. Sahadeva dasa

B.com., FCA., AICWA., PhD
Chartered Accountant

Soul Science University Press

www.cowdung.org

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Dedicated to....

His Divine Grace A.C.Bhaktivedanta Swami Prabhupada

Pancha-gavya, the five products received from the cow, namely milk, yogurt, ghee, cow dung and cow urine, are required in all ritualistic ceremonies performed according to the Vedic directions. Cow urine and cow dung are uncontaminated, and since even the urine and dung of a cow are important, we can just imagine how important this animal is for human civilization. Therefore the Supreme Personality of Godhead, Krishna, directly advocates go-raksa, the protection of cows.
~ Srimad Bhagavatam 8.8.11

By The Same Author

Oil–Final Countdown To A Global Crisis And Its Solutions

End of Modern Civilization And Alternative Future

To Kill Cow Means To End Human Civilization

Cow And Humanity – Made For Each Other

Cows Are Cool – Love 'Em!

Let's Be Friends – A Curious, Calm Cow

Wondrous Glories of Vraja

We Feel Just Like You Do

Tsunami Of Diseases Headed Our Way – Know Your Food Before Time Runs Out

Cow Killing And Beef Export – The Master Plan To Turn India Into A Desert By 2050

Capitalism Communism And Cowism – A New Economics For The 21st Century

Noble Cow – Munching Grass, Looking Curious And Just Hanging Around

World – Through The Eyes Of Scriptures

Spare Us Some Carcasses – An Appeal From The Vultures

To Save Time Is To Lengthen Life

Life Is Nothing But Time – Time Is Life, Life Is Time

An Inch of Time Can Not Be Bought With A Mile of Gold

Lost Time Is Never Found Again

(More information on availability on DrDasa.com)

Contents

Preface

One of the biggest obstacles to making a start on climate change is that it has become a cliche before it has even been understood. Environmental crisis is for real and it's coming around faster than you think. It's not a brainchild of some conspiracy theorist but a tangible, perceivable fact, proven by the catastrophic events all over the world.

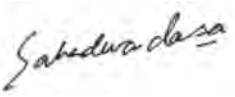
But for most of us, caught up in the daily grind, it's hardly a subject worth pondering over. Common man in the streets of London, New York or Delhi has very little time to worry about some ozone layer up there or some damn iceberg in the North Pole. At best, it is a snow bear's problem.

But the scientific fraternity and many political leaders don't think so. They are waking up to the horrors of global warming and climatic change. Hectic efforts are on to contain the damage but with very little success.

This book provides a simple solution to this grave crisis which has the potential to wipe out life altogether. This is a calamity of unprecedented proportions coming our way and a point of no return for the industrial civilization.

One of the arguments sceptics throw back at you is that the climate has always changed, and that is absolutely right. It's the rate of change that is the problem right now. It's changing so quickly that it exceeds our adaptive capacity.

We are in a hole and it's time to stop digging.



Dr. Sahadeva dasa
1st August 2014
Secunderabad, India

Section-I

Environmental Crisis Is For Real

And It's Coming Around Faster Than You Think

1.

Environmental Crisis

Death Of A Small Planet

Scott Taylor defines environmental crisis as a dramatic, unexpected, and irreversible worsening of the environment leading to significant welfare losses.[1]

Such crisis occurs when the environment of a species or a population changes in a way that destabilizes its continued survival.

Across the board it is a well-accepted fact that our environment is in grave danger. This is starting to have major impacts on ecosystems. Ecosystems are trying to change or evolve to cope with the climate change. Many species are being driven out of their habitats. Natural calamities are becoming the order of the day and costs are spiralling out of control.

Apart from climate change and global warming, other key environmental problems include air pollution, the destruction of the ozone layer, vast quantities of toxic waste, massive levels of soil erosion, the peaking of key natural resources such as oil and coal, and the extinction of plants and animals on a scale not seen before.

Although the window is now small and we still have the luxury to discuss it, we continue with our wasteful behavior. Options are not

too many for the great majority of poor people around our planet who have to deal day-to-day with bare survival. [2]

The causes are many but almost all of them flow from our unrestricted exploitation of environment. Gigantic industrial enterprise with dangerous technologies is leaving behind a permanent trail of devastation.

Ours is closed-loop system: what happens one place eventually travels to other global areas. Decades ago, we thought that the planet had limitless natural resources. It does not. If we are to survive as a race, we need ethical and fiscal responsibility –neither of which is anywhere to be found now in public policy or discourse. All we have is one massive fraud after another.[3]

Nothing much can be expected from the governments either. They are bankrupt, economically, morally and ethically.

In Jared Diamond's 2005 book, "Collapse: How Societies Fail or Succeed," the UCLA professor discusses how some ancient and contemporary societies have gone the way of the proverbial dodo bird, because of basic issues (often with an environmental base) that usually transcended each individual society's knowledge [e.g.,

"We believe there is compelling evidence that damage to humans and the worldwide environment, is of such magnitude and seriousness that new principles for conducting human activities are necessary."
~Wingspread Conference Center, January 1998.

the Maya or Easter Islanders]. While he does discuss how some societies have succeeded, the majority have not. Over thousands of years of recorded history, empires have risen and fallen. Today's leaders, however, do not care about lessons from the past.

In an insightful article in Smithsonian magazine, Dr. William Jungers of Stony Brook University is quoted as saying: "There have been many experiments in human evolution, and all of them but us have ended in extinction."[4] Given that we are now in what is called the "Sixth Extinction" (where humans have so accelerated the demise of thousands of other species), with Homo sapiens at the top of a very poisoned and collapsing food chain, the likelihood of humans wiping everything off this planet takes on a far greater reality. The rapacious nature of our species has given rise to a new name: "Homo rapians." There is far more than a grain of truth to this tongue-in-cheek nomenclature[5], since those in charge of governments and corporations are showing the very worse of human behavior –at a time where our planet and every living species is in crisis.

Certainly, with our collapsing planetary-wide scenario, there is no thought of any kind of precaution. Environmental crisis is just another nail that has been hammered into our collective coffin.[6]

References:

1. M. Scott Taylor, Department of Economics, University of Calgary, Canadian Journal of Economics, Nov. 2009

2, 3, 6. The Worldwide Environmental Crisis -Gone Missing: The Precautionary Principle, Dr. Ilya Sandra Perlingieri, Global Research, February 11, 2009

"We must heed early warnings, when we are not sure of the effects of our actions. We must act as trustees for the world that we inherited. This means we must be good stewards, so that we pass on to our children and grandchildren a world that is not so enormously polluted."

~ Dr. Peter Montague

4. Thomas Hayden. "What Darwin Didn't Know." "Smithsonian" Feb. 2009, Vol. 39, No. 11: 48

5. Jason Miller. "Homo rapians be damned. Savagery is not programmed into our DNA." Feb. 3, 2009. www.heyokamagazine.com/ heyoka_magazine.26.jasonmiller.homrapiens.htm

2.

Get Ready For Extreme Weather

Warning From The Intergovernmental Panel On Climate Change (IPCC)

Think of the Texas drought, floods in Thailand and Russia's devastating heat waves as coming attractions in a warming world. That's the warning from top international climate scientists and disaster experts after meeting in Africa.

The panel says the world needs to get ready for more dangerous and "unprecedented extreme weather" caused by global warming. These experts fear that without preparedness, crazy weather extremes may overwhelm some locations, making some places unlivable.

The Nobel Prize-winning Intergovernmental Panel on Climate Change issued a special report on global warming and extreme weather after meeting in Kampala, Uganda. This is the first time the group of scientists has focused on the dangers of extreme weather events such as heat waves, floods, droughts and storms.

All schemes are only useless scraps of paper in the face of war, famine, earthquakes and other disasters. All these disasters are warnings from Mother Durga (Material Nature), and by them she confirms her eternal superiority over the illusioned planmakers.

~ Srila Prabhupada (Teachings of Lord Chaitanya, Ch. 3)

Those are more dangerous than gradual increases in the world's average temperature.

For example, the report predicts that heat waves that are now once-in-a-generation events will become hotter and happen once every five years by mid-century and every other year by the end of the century. And in some places, such as most of Latin America, Africa and a good chunk of Asia, they will likely become yearly bakings.

And the very heavy rainstorms that usually happen once every 20 years will happen far more frequently, the report said. In most areas of the U.S. and Canada, they are likely to occur three times as often by the turn of the century, if fossil fuel use continues at current levels. In Southeast Asia, where flooding has been dramatic, it is likely to happen about four times as often as now, the report predicts.

One scientist points to the recent drought and string of 100 degree days in Texas and Oklahoma, which set an all-time record for hottest month for any U.S. state.

"I think of it as a wake-up call," says one of the study's authors, David Easterling, head of global climate applications for the U.S.

National Oceanic and Atmospheric Administration. "The likelihood of that occurring in the future is going to be much greater."

The report says world leaders have to prepare better for weather extremes.

"We need to be worried," says one of the study's lead authors, Maarten van Aalst, director of the International Red Cross/Red Crescent Climate Centre in the Netherlands. "And our response needs to anticipate disasters and reduce risk before they happen rather than wait until after they happen and clean up afterward. ... Risk has already increased dramatically."

Another study lead writer, Chris Field of Stanford University, says scientists aren't quite sure which weather disaster will be the biggest threat because wild weather interacts with economics and where people live. Society's vulnerability to natural disasters, aside from climate, has also increased, he adds.

Field told The Associated Press in an interview that "it's clear that losses from disasters are increasing. And in terms of deaths, "more than 95 percent of fatalities from the 1970s to the present have been in developing countries," he said.

Impelled by false ego, one dreams of the material world without the Personality of Godhead and makes plans to lord it over nature, to exploit her resources. Modern atheistic scientists have developed this false ego to a fine art and imagine themselves great heroes conquering the obstacles of nature and moving forward toward inevitable omniscience. Such dreamy materialists are repeatedly stunned by the crushing reactions of the laws of nature, and their arrogant, agnostic civilizations are repeatedly annihilated by world wars, natural disasters and violent shifts of the cosmic situation.

~ Srimad Bhagavatam 11.28.3 purport

Losses are already high, running at as much as $200 billion a year, says Michael Oppenheimer of Princeton University, a study author.

Science has progressed so much in the last several years that scientists can now attribute the increase in many of these types of extreme weather events to global warming with increased confidence, writes another study's author Thomas Stocker at the University of Bern.

Scientists were able to weigh their confidence of predictions of future climate disasters and heat waves were the most obvious. The report says it is "virtually certain" that heat waves are getting worse, longer and hotter, while cold spells are easing.

The report further states there is at least a 2-in-3 chance that heavy downpours will increase, both in the tropics and northern regions, and from tropical cyclones.

The 29-page summary of the full report warns that extremes could get so bad at some point that some regions may need to be abandoned.

Such locations are likely to be in poorer countries but the middle class may be affected in those regions, which aren't specifically identified in the report. And even in some developed northern regions of the world, such as Canada, Russia and Greenland, cities might need to move because of weather extremes and sea level rise from man-made warming.

And it's not just the headline grabbing disasters like a Hurricane Katrina or the massive 2010 Russian heat wave that studies show were unlikely to happen without global warming. At the Red Cross/ Red Crescent they are seeing "a particular pattern of rising risks" from smaller events.

Of all the weather extremes that kill and cause massive damage, according to the report, the worst is flooding.

There's an ongoing debate in the climate science community about whether it is possible and fair to attribute individual climate disasters to manmade global warming. Usually meteorologists say it's impossible to link climate change to a specific storm or drought, but that such extremes are more likely in a future dominated by global warming.

Jerry North, a scientist at Texas A&M University who wasn't part of the study, says he thought the panel was being properly cautious in its projections and findings, especially since by definition climate extremes are uncommon events. MIT professor Kerry Emanuel thought the panel was being too conservative when it comes to tropical cyclones.

The panel was formed by the United Nations and World Meteorological Organization. In the past, it has discussed extreme events in snippets in its report. But this time, the scientists are putting them together.

We must understand the laws of nature from the viewpoint of the Supreme Lord, who has created these laws. In His eyes all the earth's inhabitants -- whether creatures of the land, water, or air -- are His sons and daughters. Yet we, the human inhabitants, the "most advanced" of His creatures, treat these sons and daughters with great cruelty, from the practice of animal slaughter to destruction of the rain forests. Is it any wonder that we suffer an unending series of natural disasters, wars, epidemics, famines, and the like?

The source of our problem is the desire for sense gratification beyond the consideration of anyone else's rights. These rights are the rights of the child in relation to the father. Every child has the right to share the wealth of his father. So creating a brotherhood of all creatures on earth depends on understanding the universal fatherhood of God.

~ Laws of Nature - An Infallible Justice, Introduction

Sources:

1. Seth Borenstein, Huffington Post, November 18, 2011, Washington.

2. Peter Montague. Key Note speech. Global Warming Conference, University of Maine, Farmington. May 6, 2006.

3. Keith, David W. (2000) Geoengineering the climate: History and prospect,í Annual Review of Energy and the Environment 25, 245-84

3.

Scientists: Natural Disasters Becoming More Common

Earth might seem like a more active and dangerous place than ever, given the constant media reports of multiple natural disasters recently. But a broader view reveals that it's not Mother Nature who's changed, but we humans.

Along with the Office of US Foreign Disaster Assistance (OFDA), Center for Research on Epidemiology of Disasters (CRED) maintains an emergency disaster database called EM-DAT. An event is categorized as a natural disaster if it kills 10 or more people or leaves at least 100 people injured, homeless, displaced or evacuated. An event is also included in the database if a country declares it a natural disaster or if requires the country to make a call for international assistance.

According to the EM-DAT, the total natural disasters reported each year has been steadily increasing in recent decades, from 78 in 1970 to 348 in 2004.

A small portion of that increase is artificial, due in part to better media reports and advances in communications. However, most of the increase is real and the result of rises in hydro-meteorological disasters. These disasters include droughts, tsunamis, hurricanes,

typhoons and floods and have been increasing over the past 25 years. In 1980, there were only about 100 such disasters reported per year but that number has risen to over 300 a year since 2000.

Even natural geologic disasters, such as volcanic eruptions, earthquakes, landslides and avalanches are becoming more vicious and causing greater damage.

What's Going On?

Scientists believe the increase in hydro-meteorological disasters is due to a combination of natural and made-made factors. Global warming is increasing the temperatures of the Earth's oceans and atmosphere, leading to more intense storms of all types, including hurricanes.

Natural decadal variations in the frequency and intensity of hurricanes are also believed to be a contributing factor, as are large-scale temperature fluctuations in the tropical waters of the Eastern Pacific Ocean, known as El Niño and La Niña.

People are also tempting nature with rapid and unplanned urbanization in flood-prone regions, increasing the likelihood that their towns and villages will be affected by flash floods and coastal floods.

People aren't just putting themselves at risk for floods, but for natural disasters of all types, including earthquakes and storms like hurricanes and typhoons.

According to the World Bank's "Natural Disaster Hotspots: A Global Risk Analysis" report released in March, more than 160 countries have more than a quarter of their populations in areas of high mortality risks from one or more natural disasters. Taiwan was singled out as being the place on Earth most vulnerable to natural disasters, with 73 percent of it's land and population exposed to three or more threats.

Source:
Ker Than, Live Science, October 17, 2005
Roe, Gerard H., and Marcia B. Baker (2007a) 'Why is climate sensitivity so unpredictable?' Science 318, 629-32

What, then, are the problems of existence? First, there are the fourfold miseries birth, death, disease and old age. There are miseries caused by other living entities, such as biting bugs and human enemies; there are miseries caused by the very nature of our bodies, such as mental anxiety, indigestion and broken limbs, and there are miseries inflicted on us by natural calamities beyond human control, such as earthquakes, droughts and floods. For our education to be fruitful, it should help us find a solution these problems.

One might object to our assumption that human life should yield freedom from miseries. Some people think misery the natural human condition. They say we are meant–to suffer. Nevertheless, living entities of all species want to be happy and avoid suffering; no one takes suffering naturally. Misery may seem inevitable, yet philosophers, humanitarians and politicians ever seek its remedies. Not only does a human being try to avoid suffering; even an ant resists being killed. Ask anyone if he is eager to deteriorate with old age. To answer honestly, one would have to say no. What about disease or death? Would anyone like to die right now? "No thanks." Sometimes people try to block out suffering with sensual pleasure. For example, one might temporarily forget one's anxieties through drugs or liquor. But after the high wears off, the anxieties return.

~ The Education To End All Miseries, Satsvarupa Dasa Gosvami

4.

It's Not Your Imagination

The Number Of Disasters Just Keeps Rising

David Carter, 69, who lives in the Philippines with his Filipino wife Lydia and their three adopted children, lost the emergency tent they were living in when the typhoon ravaged his home town. This was just weeks after an earthquake wrecked the home he built.

Speaking of his 'terrifying' ordeal, he said that the community looked like a 'nightmare scene that even Hollywood couldn't create' since the disaster struck the town.

His town, Loon, on Bohol Island in Philippines was devastated by two natural disasters in quick succession.

Mr Carter, a former property developer, had built his house from scratch around 17 years ago.

'We never expected anything like this to ever happen,' he said.

'I was just in the house when the earthquake hit and I just shouted to my children to get out just in time before the house fell.'

Mr Carter, from Burnley, Lancashire, spent most of his career in England with Lydia before the pair moved to the country permanently 20 years ago.

He recalls, 'After the collapse of our home, we were living in a tent, then when the high winds hit my wife and I just held hands in our tent and prayed that it would pass. But the tent was blown away. We feel lucky to be just alive.'

'Now the town looks completely unrecognisable, the whole population are desperately short of supplies and the whole island is without power.'

'The only way aid can get through is by helicopter or by making a five hour dangerous journey through the mountains where there are a lot of landslides.'

Yet despite his situation Mr Carter is determined to stay put.

He says: 'Loon is my home and there is nothing that would make me leave it or the people here. I intend to completely rebuild my house and will not give up until it's completely restored, however long it may take.'

Source:
The Daily Mail, Sara Malm, 16 November 2013

As society becomes ever more desperate to learn to cope with the relentless toll of worldwide social upheaval and disorder -- not to mention the cataclysmic natural disasters that fall thick and fast about our ears -- its need for an alternative socio-philosophical system will fill the vacuum created by the pursuit of an exclusively physical science that has, for too long, denied the validity of its counterpart, metaphysical science.

~ Bhaktivedanta College, South Africa

5.

Insured Claims From Natural Catastrophes

Increasing Dramatically.

Experts on natural catastrophe risk at Allianz have highlighted the growing trend in insured losses arising from natural catastrophes worldwide in a risk briefing – the Allianz Risk Pulse: Focus Natural Catastrophes – which is released in June 2014. The average annual cost of insured claims from natural catastrophes has increased eight-fold since 1970 (up from some US$5 billion in the

1970s and 1980s to over US$40 billion in 2010). Climate change and economic growth are the two reasons. Property values are rising, population density and insurance penetration are increasing, often in high risk areas. But the impact of climate change need to be closely watched.

In The Long Term, Things May Become Uninsurable: Report

Peter Hoppe heads the Geo Risks Research center for Munich Re, a global company that insures other insurers. His company put out a report just before Sandy warning that North America will face a rising number of natural catastrophes due in part to greenhouse gas emissions.

"We believe that climate change is a big problem and will drive losses in the future," Hoppe says.

He says there is no evidence climate change caused Hurricane Sandy. But, he says, it doesn't matter whether insurers believe in man-made climate change. His report says the number of weather-related events nearly quintupled in North America over the past three decades. And that means premiums will increase in the long run if exposure continues to increase.

"On the long term, definitely we have an interest in what will be happening in 50 years, or even in 100 years because this concerns our business model in general. It may be that in the long term, things become uninsurable," Hoppe says.

The insurance industry plays an important role when it comes to helping those affected by natural catastrophes, advising on preparedness and prevention and analyzing risk. Teams of claims regulators, risk managers, natural catastrophe experts and economic research specialists work hard to support clients and to understand natural catastrophes and their effects.

6.

Billion-Dollar Weather/Climate Disasters

The National Climatic Data Center (NCDC) is America's Scorekeeper in terms of addressing severe weather/climate events in their historical perspective. As part of its responsibility of monitoring and assessing the climate, NCDC tracks and evaluates climate events in the U.S. and globally that have great economic and societal impacts. NCDC is frequently called upon to provide summaries of global and U.S. temperature and precipitation trends, extremes, and comparisons in their historical perspective. Found here are the weather/climate events that have had the greatest economic impact from 1980 to 2013. The U.S. has sustained 151 weather/climate disasters since 1980 where overall damages/costs reached or exceeded $1 billion. The total cost of these 151 events exceeds $1 trillion.

2013 In Context

In 2013, there were 7 weather and climate disaster events with losses exceeding $1 billion each across the United States. These events included five severe weather and tornado events, a major flood event, and the western drought / heat wave. Overall, these events killed 109 people and had significant economic effects on the areas impacted.

Reference:

Smith, A., and R. Katz, 2013: U.S. Billion-dollar Weather and Climate Disasters: Data Sources, Trends, Accuracy and Biases. Natural Hazards, DOI 10.1007/s11069-013-0566-5.

Just as federal laws govern a nation, so God's laws govern the universe. And just as the state punishes a thief or a murderer, so God punishes a nation that transgresses His laws. This punishment takes such forms as natural disaster, social disorder, economic hardship -- and war. Ancient India's Vedic literatures give us this basic law for a peaceful world: "Everything animate or inanimate that is within the universe is controlled and owned by the Lord. One should therefore accept only those things necessary for himself -- those things set aside as his quota -- and one must not take other things, knowing well to whom they belong." (Isa Upanisad, mantra 1)

7.

Floods, Landslides, Fire And Drought

A Climatic Post-mortem of Year 2011

Extreme Weather Becoming The Norm

London (CNN) -- Global mean temperatures in the year 2011 might not have scaled the record-equaling heights of 2010, but it's been another tumultuous 12 months.

According to the World Meteorological Organization's (WMO) provisional status report, issued at the United Nations climate talks in Durban, 2011 was the 10th warmest year on record and warmer than any other year with a La Nina event.

La Nina -- an opposite weather pattern to El Nino which cools surface waters in the eastern and central Pacific -- occurs two to three times a decade on average, says climatologist and scientific coordinator of the WMO statement Blair Trewin.

This most recent one -- which started in the second half of 2010 and continued until May this year -- has been one of the strongest in the past 60 years, says the WMO, and was "closely associated" with many of the regional weather events that have dominated the headlines throughout the year.

January saw floods in northeast Australia -- the worst in Queensland's capital, Brisbane since 1974 -- and deadly landslides caused by a deluge of rain in Brazil.

The appalling disaster in a mountainous region around 60 kilometers north of Rio de Janeiro claimed at least 900 lives, according to the WMO, making it the single most deadly weather event of the year.

Heavy rains also caused many regions of the world to flood in 2011 including parts of southern Africa, Central America and southern states of Europe.

But it was major flooding in Southeast Asia that dominated the news as the year came to a close, wiping out more than 650 lives in Thailand, and dozens more in neighboring Myanmar and Cambodia.

Rainfall during June to September's monsoon season in northern and central Thailand was up to 80% higher than the seasonal average, says the WMO.

The situation came to a head in October as already inundated natural waterways combined with high tides to swamp the Thai capital Bangkok.

Among the other more notable extremes of weather in 2011 were the huge weather disparities experienced in the U.S.

The WMO reported 14 separate climate events this year in the U.S. which they estimate caused losses upwards of $1 billion.

Heavy snow fell across southern and Midwestern states -- including Oklahoma, Kansas and Missouri in February.

April and May played host to one of the most active tornado seasons on record, according to the WMO, and the Mississippi River suffered its worst floods in nearly 80 years.

But 600 miles west in Texas a drought was taking hold and wildfires raged.

Summer temperatures in the Lone Star State averaged 30.4 degrees Celsius - 3 degrees Celsius higher than the long-term average and the highest-ever recorded in any American state.

All the while, many northeastern states and parts of southern Canada were experiencing their wettest year on record -- the most severe flooding coming in the wake of Hurricane Irene in late August and Tropical Storm Lee which followed quickly on her heels.

Elsewhere, the Horn of Africa endured a terrible drought which put up to 12 million people at risk of starvation until October's rains eased the threat. But such was their intensity -- Wajir, northeast Kenya received more rain in six weeks (402 millimeters) than the annual average -- it led to crop damage.

The general warming trend -- 13 of the warmest years have occurred in the 15 years since 1997 -- was highlighted by summer sea ice melt in the Arctic.

"Our science is solid and it proves unequivocally that the world is warming ..." WMO secretary-general Michel Jarraud said on publication of the provisional report.

Human activities are to blame, Jarraud says, and temperatures are "rapidly approaching" a level which scientists believe could kick-start "far-reaching and irreversible" climate change.

Source:
By Matthew Knight, CNN
December 7, 2011

8.

Cost Of Natural Disasters 'Out Of Control'

As US Clean-Up Bill Hits $100 Bn

UN's Stark Warning To The World's Business Community

As figures from the Natural Resources Defense Council (NDRC) estimate the US government paid out nearly $100 billion in the aftermath of drought, floods and fires in 2012, the UN Secretary General has warned that economic losses caused by natural disasters are "out of control".

Speaking in New York at the launch of a new UN report on the business case for disaster risk reduction, Ban Ki-Moon warned

that the economic losses from disasters are being underestimated by around 50%.

He said, "Our startling finding is that direct losses from floods, earthquakes and drought have been underestimated by at least 50%. So far this century, direct losses from disasters are in the range of $2.5 trillion. This is unacceptable when we have the knowledge to reduce the losses and benefit from the gains."

The report – in partnership with the UN Office for Disaster Risk Reduction (UNISDR) and consultancy Pricewaterhouse Coopers (PwC) – offered a stark warning to the world's business community that these costs will continue to escalate in coming years. It warned companies must start mitigating for the potential impacts that they face.

The globalisation of the world's economy over the past 40 years has led to a rapid increase in disaster risk in all countries – both rich and poor – argued the report.

For example, the 2011 Thailand floods affected a number of electronic component manufacturers. Sony and Toyota were forced to close regional factories. Intel had to cut $1 billion from its quarterly profit projections in the wake of the floods.

And while governments bear responsibility for measures to mitigate disasters, Ban warned that the private sector also has a critical role to play. It accounts for 70-85% of worldwide investment in new buildings, industry and critical infrastructure.

He said, 'The principles of disaster risk reduction must be taught at business schools and become part of the investor's mind-set'.

A recent poll shows people nearly across the board rate climate change near the bottom of their list of problems facing the nation. Why? Climate is big, intangible, and hard to wrap our brains around. We can't hold it in our hands or look it in the eye. Or can we?

~ Rodale Institute

A US Case Study

The warning from the UN has been further amplified by new estimates from the NDRC showing the US government paid out $96 billion in the aftermath of drought, floods and fires in 2012.

This was the country's biggest non-defence related spending and works out at around $1,100 per taxpayer. The US government spent more in 2012 cleaning up after natural disasters than they did on education or health.

Superstorm Sandy, drought-induced crops failures, floods and forest fires all contributed to the costs.

Overall the insurance industry estimates that 2012 was the second costliest year in US history for climate-related disasters, with over $139 billion in damages. While private insurers covered about 25% of these costs ($33 billion), the federal government and its public insurance enterprises picked up the majority of the bill.

Dan Lashof, co-author of the report and director of NRDC's Climate and Clean Air Program said, 'While Congress debates the federal budget, our government is spending more responding to extreme weather made worse by climate change than we are to educate our kids or take care of our bridges and roads. In fact, this single-ticket expense now tops the list of non-defence discretionary federal spending. And taxpayers are shouldering more of the burden—they are spending three times more than private insurers to pay for recovery from climate damages.'

Source:

Tierney Smith, TckTckTck, May 24, 2013

Matthews, H. Damon, and David W. Keith (2007) 'Carbon-cycle feedbacks increase the likelihood of a warmer future,' Geophysical Research Letters 34, L09702

9.

100 Million People Will Die By 2030

If World Fails To Act On Climate: Report

More than 100 million people will die and global economic growth will be cut by 3.2% of gross domestic product (GDP) by 2030 if the world fails to tackle climate change, a report commissioned by 20 governments said in Sept. 2012. As global average temperatures rise due to greenhouse gas emissions, the effects on the planet, such as melting ice caps, extreme weather, drought and rising sea levels, will threaten populations and livelihoods, said the report conducted by humanitarian organisation DARA.

It calculated that five million deaths occur each year from air pollution, hunger and disease as a result of climate change and carbon-intensive economies, and that toll would likely rise to six million a year by 2030 if current patterns of fossil fuel use continue.

More than 90% of those deaths will occur in developing countries, said the report that calculated the human and economic

impact of climate change on 184 countries in 2010 and 2030. It was commissioned by the Climate Vulnerable Forum, a partnership of 20 developing countries threatened by climate change.

"A combined climate-carbon crisis is estimated to claim 100 million lives between now and the end of the next decade," the report said.

It said the effects of climate change had lowered global output by 1.6 percent of world GDP, or by about $1.2 trillion a year, and losses could double to 3.2% of global GDP by 2030 if global temperatures are allowed to rise, surpassing 10 percent before 2100.

It estimated the cost of moving the world to a low-carbon economy at about 0.5% of GDP this decade.

Counting The Cost

British economist Nicholas Stern told Reuters earlier this year investment equivalent to 2% of global GDP was needed to limit, prevent and adapt to climate change. His report on the economics of climate change in 2006 said an average global temperature rise of 2-3 degrees Celsius in the next 50 years could reduce global consumption per head by up to 20%.

Temperatures have already risen by about 0.8 degrees Celsius above pre-industrial times. Almost 200 nations agreed in 2010 to limit the global average temperature rise to below 2C (3.6 Fahrenheit) to avoid dangerous impacts from climate change.

But climate scientists have warned that the chance of limiting the rise to below 2C is getting

smaller as global greenhouse gas emissions rise due to burning fossil fuels.

The world's poorest nations are the most vulnerable as they face increased risk of drought, water shortages, crop failure, poverty and disease. On average, they could see an 11% loss in GDP by 2030 due to climate change, DARA said.

"One degree Celsius rise in temperature is associated with 10% productivity loss in farming. For us, it means losing about 4 million metric tonnes of food grain, amounting to about $2.5 billion. That is about 2 percent of our GDP," Bangladesh's Prime Minister Sheikh Hasina said in response to the report.

"Adding up the damages to property and other losses, we are faced with a total loss of about 3-4% of GDP."

Even the biggest and most rapidly developing economies will not escape unscathed. The United States and China could see a 2.1 percent reduction in their respective GDPs by 2030, while India could experience a more than 5% loss.

Source:
Nina Chestney, Reuters,
London, September 26, 2012

10.

Climate Change, Natural Disasters Could Displace 200 Million People By 2050

Refugees International Report

The U.S. and other countries must recognize the threat represented by the massive floods that hit Pakistan in the year 2010 and increase preparation for a growing number of natural disasters caused by climate change, according to a report released in November 2010.

It is estimated that as many as 200 million people will be displaced by natural disasters and climate change around the world by 2050, said the report by Washington, D.C.-based Refugees International. The world's poorest and most crisis-prone countries will be disproportionately affected.

"The massive flooding in Pakistan is a wake-up call that starkly highlights the real threats we face from climate-related disasters," said Michel

Gabaudan, president of Refugees International. "Given the high costs of responding to these catastrophic events, it is in our best interest to plan now for the massive human displacement they cause and protect those most at risk."

2010 summer's floods in Pakistan submerged one-fifth of the country, an area the size of Louisiana, and affected more than 20 million people. The disaster caught both the Pakistani government and the humanitarian community by surprise and overwhelmed their response capabilities.

Many experts believe the floods were the result of climate change, said the report. Others believe the science is uncertain, it said, but

Upwards of one-third of the human population lives in coastal areas that would be threatened by rising sea-level. This is roughly 2 billion people. How long would it take to move this many people inland and create infrastructures capable of support?

Agriculture: Humanity has already overextended its food resources. Crops cannot pack up and move as people can. It may be possible in the gradualist scenarios that people could slowly change their agricultural patterns over time to accord with changed temperature or rainfall. It is doubtful that this could happen very successfully in a situation where there was radical change in a decade. Further, most of the world survives not based upon agri-business, but rather on settled, subsistence farming whose strength rests on the farmers having a long-developed understanding of their land and crops. Sudden change would negate this understanding.

A small-scale example of man's inability to adjust to climate change can be seen in the steady desertification of much of the Sahel region in Africa, where the Sahara has been advancing. This has led to severe dislocation, starvation and social instability. The climatic oscillations outlined above would be far more widespread and devastating than anything witnessed in Africa.

In sum, what has been called the gloom-and-doom warnings of the long-term effects of global warming may actually turn out to have been optimistic. The future could well be far more catastrophic than is generally projected.

most agree that natural disasters are occurring more frequently and that the international community is ill-equipped to respond.

"The floods in Pakistan provide an opportunity to draw lessons and address some of the underlying factors that rendered so many people vulnerable to begin with," said Alice Thomas, co-author of the report and Climate Displacement Program Manager for Refugees International.

"With some foresight and critical thinking, we can implement effective programs to prevent long-term displacement and get people back on their feet more quickly after a disaster occurs," she added.

The organization called on the United States, which is the largest donor to Pakistan, to prepare a report on how its assistance will help the country prepare for climate-related disasters. That includes reducing risk to the most vulnerable residents, who are often the poorest, and improving the government's response when a disaster hits.

"The failure to address the threat of climate displacement could undermine the long-term stability of countries likely to experience

Over three decades, about 1.3 million square miles of Arctic sea ice has disappeared, equivalent to 42% of the area of the lower 48 states.

Climate models previously projected that the Arctic might lose almost all of its summer ice cover by 2100, but some scientists said they believe the trend is accelerating and that it will be gone long before then.

In addition to the extent of sea ice, what remains is thinner than it used to be.

~Walter Meier, National Snow and Ice Data Center, University of Colorado, Boulder.

increased floods, storms, droughts and other disasters," said Gabaudan, the Refugees International chief. "Taking preventive steps now will strengthen these countries and provide support to the world's poorest people."

Source:
Sebastian Abbot, Huffington Post, November 22, 2010.

The science of ecology has awakened us to a greater appreciation of how different organisms and natural resources are linked in complex interdependency, and how easily this interdependency can be disturbed -- as in the case of acid rain, for example. While doing research for NASA, scientist Jim Lovelock concluded that the "earth's living matter, air, oceans, and land surface form a complex system which can be seen as a single organism and which has the capacity to keep our planet a fit place for life." He calls his hypothesis the "Gaia principle," after the Greek goddess of the earth.

He points out, "The concept of Mother Earth, or, as the Greeks called her long ago, Gaia, has been widely held throughout history and has been the basis of a belief which still coexists with the great religions." The Vedic scriptures clearly state that the earth is the visible form of the goddess Bhumi, who restricts or increases her production according to the population's level of spiritual consciousness.

~ Drutakarma Dasa

11.

Experts Warn Of Superstorm Era To Come

'Sandy Is A Foretaste Of Things To Come'

New York (CNN) -- Superstorm Sandy was no freak, say experts, but rather a hint of a coming era when millions of Americans will struggle to survive killer weather.

They're telling us we shouldn't be surprised that this 900-mile-wide monster marched up the East Coast paralyzing cities and claiming scores of lives.

"It's a foretaste of things to come," Princeton University professor Michael Oppenheimer told CNN. "Bigger storms and higher

Superstorm Sandy Breaks Records

Superstorm Sandy, which New York Mayor Bloomberg called "a storm of unprecedented proportions," can claim several historical titles.

Sandy's strength, as indicated by barometric pressure just before landfall, set a record. The lower the pressure, the stronger the storm.

When hurricane hunter aircraft measured its central pressure at 940 millibars, it was the lowest barometric reading ever recorded for an Atlantic storm to make landfall. The previous record holder was the 1938 "Long Island Express" Hurricane, which dropped as low as 946 millibars.

Sandy's strength and angle of approach combined to produce a record storm surge of water into New York City. The surge level at Battery Park topped 13.88 feet, surpassing the 10.02 feet record water level set by Hurricane Donna in 1960.

New York Harbor's surf also reached a record level when a buoy measured a 32.5-foot wave. That wave was 6.5 feet taller than a 25-foot wave churned up by Hurricane Irene in 2011.

As Sandy approached the Northeast, forecasters were fond of pointing out that if the hurricane were a country, the area it covered would make it the 20th largest in the world -- roughly twice the size of Texas.

But with tropical-force winds reaching out 580 miles, Sandy still was just the second-largest Atlantic storm on record. Hurricane Olga, another late-in-the-year storm, set the record in 2001, with tropical-force winds extending 600 miles, according to the National Hurricane Center.

Sandy's power cut electricity service to a record number of people in the Northeastern United States, according to utility company numbers.

There were 7.5 million businesses and households without electric power in 15 states and the District of Columbia, according to numbers compiled by CNN from local power providers.

"This is the largest storm-related outage in our history," John Miksad, Con Edison senior vice president for electric operations, said in a company Twitter message. ~ Alan Duke, CNN, October 31, 2012

sea levels" will pile on to create a "growing threat" in the coming decades.

And New York, he warned, "is highly vulnerable."

How can cities defend themselves against such powerful enemies? Some of the ideas out there may surprise you.

They range from building higher sea walls and barrier islands to restoring oyster beds and installing massive gates across estuaries.

New York Mayor Michael Bloomberg has been strategizing.

His goal: mitigate future storm surges and flooding along the city's 500 miles of coastline.

That's a huge challenge. The densely populated city is dominated by some of the nation's most expensive real estate and is surrounded by a complex web of estuaries, tides and ocean.

New York dodged a bullet by inches last year as the remnants of Hurricane Irene bore down.

Princeton's Oppenheimer, a professor of geosciences, recently modeled the effect of climate change on storm surges for the New York area.

The current sea walls are about 4 to 5 feet above the average sea level. Many were built at the beginning of the last century. A New York Times article from August 1901 marveled at "The Massive Sea Wall Which Will Encompass Manhattan."

"It will be many generations, perhaps centuries, before the wall ... will have to be rebuilt or will even require any extensive repairs," the Times reported then. That was before climate change became part of the lexicon.

In a paper published by Nature in February, he and three colleagues concluded that the "storm of the century" would become the storm of "every twenty years or less."

New York Gov. Andrew Cuomo agrees.

"After what happened, what has been happening in the last few years, I don't think anyone can sit back anymore and say 'Well, I'm shocked at that weather pattern,' " Cuomo said.

The conclusion of Oppenheimer and his colleagues is that storms will become larger and more powerful.

"Climate change will probably increase storm intensity and size simultaneously, resulting in a significant intensification of storm surges," they wrote. Sandy's diameter measured much larger than most storms.

If that's not bad enough, future superstorms may threaten drinking water, too.

Ocean saltwater could compromise the quality of drinking water and weaken ecosystems, Nordenson and others concluded in their book "On the Water: Palisade Bay."

More ambitious actions would have far-reaching political and economic consequences. New York State's Sea Level Rise Task Force was created in 2007 and delivered its report to the Legislature on the last day of 2010.

According to a recent Pew Research Center poll, 67% of Americans believe the Earth is warming.

Americans are getting to the point of recognizing what they see for what it is.

Source:
By Tim Lister, CNN
October 31, 2012

12.

Superstorm Era

It's Here Already

A list of the 10 costliest Atlantic cyclones to hit the U.S. mainland since 1900 is given here. Figures are not adjusted for inflation.

Rank	Name	Year	Damage
1	Katrina	2005	$108 billion
2	Ike	2008	$29.5 billion
3	Andrew	1992	$26.5 billion
4	Wilma	2005	$21 billion
5	Ivan	2004	$18.8 billion
6	Charley	2004	$15.1 billion
7	Rita	2005	$12 billion
8	Frances	2004	$9.5 billion
9	Allison	2001	$9 billion
10	Jeanne 3	2004	$7.7 billion

Source: National Oceanic and Atmospheric Administration (NOAA)

It is interesting to see that the list contains only one super-cyclone in the 1990s whereas the rest 9 are listed in the last one decade alone. Looks like we are off to a bad start in the 21st century.

Section-II

Environmental Crisis

Role Of Carbon

13.

Carbon's Role In Climate Change

Carbon has been clobbered in the headlines lately for its link to global warming and pollution. But is this much-maligned element—the fourth most abundant in the universe—being demonized unfairly?

There's no question that carbon when paired with fellow element oxygen can spell trouble. The combo creates carbon dioxide (CO2), the root of climate change, the most destructive environmental woe facing our planet. But carbon is not inherently evil. In fact, it is a building block of life, present in all living creatures. In our daily lives we often see it in its pure form–think diamonds or lead in pencils. And it is a key ingredient in oil (made from hydrocarbons), certain types of surfboards, and even carbohydrates like bread and pasta, which provide energy for humans and animals.

So how did carbon get such a bad reputation?

It's where—and in what quantities—carbon ends up that causes trouble. Over time, our daily activity on Earth has broken the carbon cycle. When we burn fossil fuels (from the fossils of dead plants and animals) to run our cars, light our homes or make furniture, we release CO2 into the atmosphere. Normally, plants take back that CO2 via photosynthesis (the process by which plants turn sunlight into energy). Carbon dioxide can also be absorbed by the oceans. But as more CO2 is pumped out, more is accumulating in the atmosphere than the plants and oceans can take back. And too much CO2 traps heat, like a blanket covering Earth, causing the globe to warm up.

Reference:

Christie Nicholson, Scientific American, Oct 23, 2008,

Overpeck, Jonathan T., and Julia E. Cole (2006) 'Abrupt change in Earth's climate system,' Annual Review of Environment and Resources 31, 1-31

Unbridled Growth Economics

The Root Cause of Environmental Crisis

For centuries, all our spiritual traditions have told us to avoid focusing on accumulation of material goods. The familiar "Sermon on the Mount," based on the theme from Matthew 16:26 "For what doth it profit a man, if he gain the whole world, and suffer the loss of his own soul?" is rarely heard today. In the last half of the 20th century, particularly the last 25 years, the West has rejected these traditions and adopted the religion of growth economics, the fundamental principle being that if everyone pursues his or her own self interest, then society will benefit.

~George Monbiot

14.

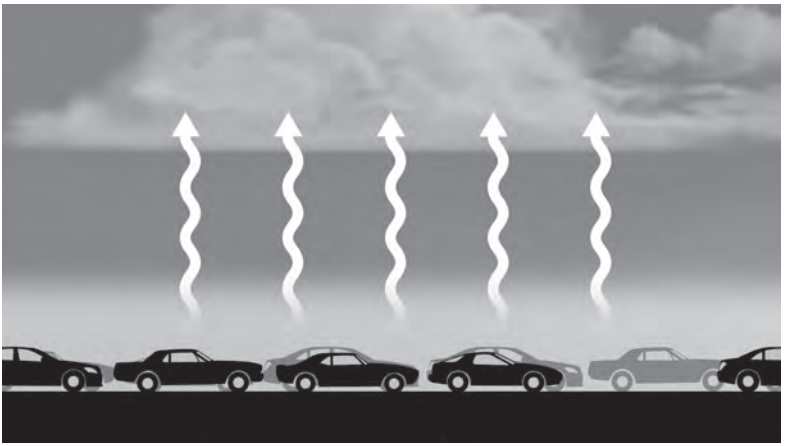
How Carbon Causes Global Warming

Why Do Carbon Dioxide Emissions Heat Up The Planet?

The temperature of the Earth depends on a balance between incoming energy from the Sun and the energy that bounces back into space. Carbon dioxide absorbs heat that would otherwise be lost to space. Some of this energy is re-emitted back to Earth, causing additional heating of the planet.

What are the major sources of carbon dioxide?

Most man-made carbon emissions come from burning fossil fuels for energy. Because of their varying chemical constituents, different fossil fuels produce different amounts of carbon dioxide.



Coal produces most, then oil, and then gas. There are other major sources as well, soil being one of them and we will examine these sources in the coming chapters. In fact soil is the single biggest source of carbon but it is not receiving the attention it deserves.

Which country produces most carbon?

The US emits the most: 5,800 million tonnes every year. Next is China, over 3,000; Russia, over 2,000; Japan, 1,200; and India, 1,000 million tonnes. Other major emitters are Germany, 800; Canada, 600m; the UK, 500m; and Italy, 47m.

Reference:
Jenny Bird, The Observer, Sunday 19 June 2005

15.

Greenhouse Gases

An Overview

A greenhouse gas is any gaseous compound in the atmosphere that is capable of absorbing infrared radiation (heat), thereby trapping and holding heat in the atmosphere.

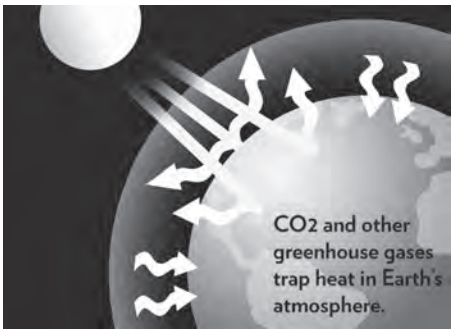
Many chemical compounds found in the Earth's atmosphere act as "greenhouse gases." These gases allow sunlight to enter the atmosphere freely. When sunlight strikes the Earth's surface, some of it is reflected back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. Over time, the amount of energy sent from the sun to the Earth's surface should be about the same as the amount of energy radiated back into space, leaving the temperature of the Earth's surface roughly constant.

Many gases exhibit these "greenhouse" properties. Some of them occur in nature (water vapor, carbon dioxide, methane, and nitrous oxide), while others are exclusively human-made (like gases used for aerosols).

In a healthy atmosphere, greenhouse gases have their rightful place. Without them, Earth's surface would average about 33 °C colder than the present average of 14 °C.

Since the beginning of the Industrial Revolution (taken as the year 1750), the burning of fossil fuels and extensive clearing of native forests has contributed to a 40% increase in the atmospheric concentration of carbon dioxide, from 280 to 392.6 parts per million (ppm) in 2012 and has now reached 400 ppm in the northern hemisphere. This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle.

A number of natural and man-made mechanisms can affect the global energy balance and force changes in the Earth's climate. Greenhouse gases are one such mechanism. Greenhouse gases in the atmosphere absorb and re-emit some of the outgoing energy radiated from the Earth's surface, causing that heat to be retained in the lower atmosphere. As explained above, some greenhouse gases remain in the atmosphere for decades or even centuries, and therefore can affect the Earth's energy balance over a long time period. Factors that influence Earth's energy balance can be quantified in terms of "radiative climate forcing." Positive radiative forcing indicates warming (for example, by increasing incoming energy or decreasing the amount of energy that escapes to space), while negative forcing is associated with cooling.



Anthropogenic carbon dioxide (CO2) emissions (i.e., emissions produced by human activities) come from combustion of carbon-based fuels, principally wood, coal, oil, and natural gas. Under ongoing greenhouse gas emissions, available Earth System Models project that the Earth's surface temperature could exceed historical analogs as early as 2047 affecting most ecosystems on Earth and the livelihoods of over 3 billion people worldwide. Greenhouse gases

also trigger ocean bio-geochemical changes with broad ramifications in marine systems.

The most abundant greenhouse gases in Earth's atmosphere are:

Water vapor (H2O)
Carbon dioxide (CO2)
Methane (CH4)
Nitrous oxide (N2O)
Ozone (O3)
CFCs

Land-use change, e.g., the clearing of forests for agricultural use, can affect the concentration of greenhouse gases in the atmosphere by altering how much carbon flows out of the atmosphere into carbon sinks.

Source:

1. National Energy Information Center (NEIC), Greenhouse Gases, Climate Change, and Energy, http://www.eia.gov/environment.html

2. NRC (2010). Advancing the Science of Climate Change . Link to EPA's External Link Disclaimer National Research Council. The National Academies Press, Washington, DC, USA.

2. U.S. Department of State (2007). Fourth Climate Action Report to the UN Framework Convention on Climate Change: Projected Greenhouse Gas Emissions. U.S. Department of State, Washington, DC, USA.

16.

A New World?

Carbon Dioxide Concentrations In Atmosphere Hit 400 PPM

Human Civilization Reaches A Climatic Milestone

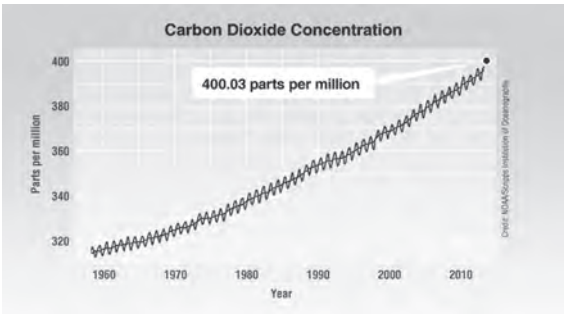
Probably for the first time in the planet's modern history concentrations of carbon dioxide in the atmosphere have struck 400 parts per million (ppm). The National Oceanic and Atmospheric Administration (NOAA) reports that readings of carbon dioxide at Mauna Loa Observatory in Hawaii hit the symbolic number on 9th May, 2013 and are expected to continue rising in coming years. According to the scientific opinion, the last time concentrations were this high for a sustained period was 4-5 million years ago when sea levels were 5-40 meters higher than today and the poles were 10 degrees celsius hotter.

"At the beginning of industrialization the concentration of CO2 was just 280ppm," says Rajendra Pachauri, chair of the Intergovernmental Panel on Climate Change (IPCC). "We must hope that the world crossing this milestone will bring about

awareness of the scientific reality of climate change and how human society should deal with the challenge."

Concentrations of carbon dioxide fluctuate depending on the season with May usually showing the highest numbers, followed by a slight dip. However, scientists say that concentrations are expected to hit 400ppm more frequently over the next few years, until eventually concentrations will remain above the milestone until the world starts slashing emissions and decades after (carbon stays in the atmosphere for 50-200 years). While scientists say that hitting 400ppm is largely a symbolic milestone, it's nonetheless illustrative of how much carbon has been pumped into the atmosphere in the last 150 years.

For most of human history, concentrations of carbon dioxide fluctuated between 180ppm and 300ppm. But the Industrial Revolution led to widespread burning of fossil fuels for energy, which released a deluge of carbon into the atmosphere. Additional carbon was emitted by the destruction of forests and other ecosystems. These emissions have raised global temperatures by about 0.8 degrees Celsius (1.4 degrees Fahrenheit) since the Industrial Revolutions leading to melting glaciers, sea level rise, vanishing Arctic sea ice, species migrations, and increases in extreme weather such as droughts and floods.



Globally, nations have pledged to keep temperatures from rising above 2 degrees Celsius (3.6 degrees Fahrenheit), however pledges and action to date have not succeeded in cutting global greenhouse gas emissions which continue to rise year-after-year. Both the World Bank and the International Energy Agency (IEA) have warned that

if business-as-usual continues, the world is headed towards a total climate catastrophe, devastating coastal cities, global agriculture, and leading to mass extinction.

Some scientists have even warned that global warming could take down human civilization as we know it.

ANYWHERE WITH ICE...A LOT OF ICE

"We're in new territory for human beings—it's been millions of years since there's been this much carbon in the atmosphere," said Bill McKibben, founder of 350.org, which campaigns for the world to move the dial on carbon concentrations down to 350 ppm. "The only question now is whether the relentless rise in carbon can be matched by a relentless rise in the activism necessary to stop it."

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Sources:

Jeremy Hance, Mongabay, May 11, 2013

Holtz-Eakin, D. (1995). "Stoking the fires? CO2 emissions and economic growth". Journal of Public Economics 57 (1): 85–101.

Herzog, T. (November 2006). Yamashita, M.B., ed. Target: intensity — an analysis of greenhouse gas intensity targets . World Resources Institute. ISBN 1-56973-638-3.

For centuries, all our spiritual traditions have told us to avoid focusing on accumulation of material goods. The familiar "Sermon on the Mount," based on the theme from Matthew 16:26 "For what doth it profit a man, if he gain the whole world, and suffer the loss of his own soul?" is rarely heard today. In the last half of the 20th century, particularly the last 25 years, the West has rejected these traditions and adopted the religion of growth economics, the fundamental principle being that if everyone pursues his or her own self interest, then society will benefit.

~George Monbiot

Section-III

Environmental Crisis

Solution Lies In Soil

Soils Store Vast Amounts Of Carbon

More Than The Atmosphere And All

Land Vegetation Combined

17.

Global Warming And Climate Change

Does the Solution Lie in the Soil?

As we have seen in the previous chapters, climate change and global warming have become the defining environmental issues facing the world. While research and practical experience consistently indicates the existence of these global trends, little has been done to combat it. Part of the reason for this is our strong dependence on energy derived from fossil fuels, such as coal and oil.

While many in government recognize the need to change our patterns of energy consumption in the long run, there is also the recognition that phasing out fossil fuel usage will be a painful process that could seriously hurt the present economy. The economic damage done could be lessened, or even eliminated, if alternative technologies, such as solar or wind power, were to advance to a point where they could rival or even undercut the cost of fossil fuels.

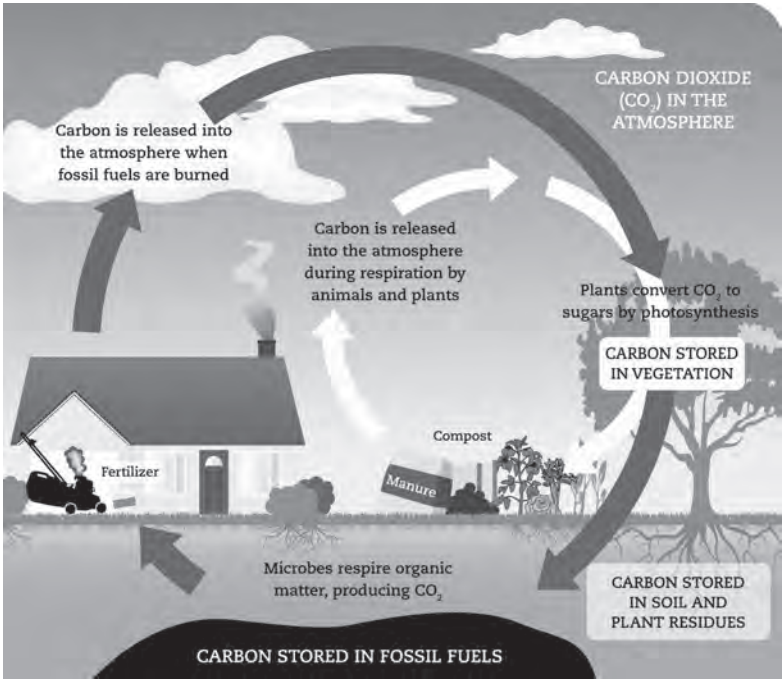
While advances in alternative technologies have greatly reduced the cost of these energy sources, fossil fuels are still the cheapest energy sources. In addition, the massive infrastructure necessary to transport fossil fuel-derived energy to customers (think of the millions of gas stations all over the world) is already in place. For the most part, alternative energy sources lack this infrastructure.

Also, so far no alternative energy source has shown the potential to replace oil in terms of cost and convenience. There is indeed no alternative in sight, otherwise Uncle Sam would not open a police station in the Middle East and sacrifice thousands of its youth.

Therefore there is an urgent need to find alternative solutions which do not encompass fossil fuel elimination. One such quick fix for global warming lies in the soil.

Soil is a part of the natural world that is both affected by and contributing to global warming. Soil is the one of the largest sources of carbon in the world. It is primarily accumulated through plants which 'fix' the carbon from carbon dioxide in the air; the soil then directly absorbs the carbon as the plants decay. Additionally, dead leaves and animals are broken down by microbes in the soil and carbon is accumulated.

Soil is what is known as a carbon sink, which means that it can capture and hold onto carbon for years rather than allowing its



release as CO2 into the atmosphere. Carbon primarily enters the soil as dead plant and animal material (leaves, twigs, carcasses etc.), feces, or CO2 dissolved in rainwater. Soil microorganisms quickly get to work breaking down this material, and while some of it is subsequently released as CO2, quite a bit of it is transformed into durable partially degraded organic material called humus. The carbon in humus can remain untouched for hundreds, sometimes even thousands, of years. If properly managed, the humus level, and thus the carbon level, of soils can increase with time.

In order to see significant carbon increases, a soil must be protected. This means shielding the soil from oxidation and other forms of degeneration. Oxidation occurs when a soil is sifted and broken up, such as when it is plowed, especially by the big machinery in industrial agriculture. Such plowing exposes a lot of the subsoil humus to the atmosphere, and the increased oxygen levels allow for quicker breakdown of organic material and thus more CO2 output. Therefore, to increase the levels of carbon stored in soil and combat the rise of CO2 in the atmosphere, national policies should emphasize conservation and protection of large swaths of soil. Then it will be possible to reduce the atmospheric CO2 levels.

It is a widely accepted fact that soil carbon sink is a promising ally in the fight against climate change and global warming. It is estimated globally that soils store 1,500 gigatons (1 gigaton = 1 billion tons) of carbon. By comparison, terrestrial plants store 560 gigatons, and the atmosphere holds 720 gigatons.

Reference:

Conservation Currents, Northern Virginia Soil and Water Conservation District, September 2003)

Walker, Gabrielle (2006) 'Climate change: The tipping point of the iceberg,' Nature, 441, 802-05

18.

Global Soil Change

As Serious As Climate Change

Earth's climate and biodiversity aren't the only things being dramatically affected by humans—the world's soils are also shifting beneath our feet.

'Global soil change' due to human activities is a major component of what some experts say should be recognized as a new period of geologic time: the human-made age. This new era will be defined by the pervasiveness of human environmental impacts, including changes to Earth's soils and surface geology.

Daniel Richter of Duke University, in his report published in the December 2007 issue of the journal of Soil Science, warns that Earth's soils already show a reduced capacity to support biodiversity and agricultural production. As the amount of depleted and damaged soils increases, global cycles of water, carbon, nitrogen, and other materials are also being affected.

In another paper, Jan Zalaseiwicz of the University of Leicester in England and colleagues argue that the fossil and geologic record of our time will leave distinct signatures that will be apparent far into the future.

Overworked Earth

Today about 50 percent of the world's soils are subject to direct management by humans. Global soil change is also occurring in more remote areas due to the spread of contaminants and alterations in climate. Worldwide, soils are being transformed by human activities in ways that we poorly understand, with possibly dire implications.

The report warns that properties and processes in the soil are more dynamic and susceptible to change than previously thought. Only recently it has been documented that many aspects of soil chemistry and composition are highly responsive to human activities.

Report also warns that severe soil degradation is increasing globally at a rate of 12.4 million to 24.7 million acres (5 million to 10 million hectares) annually.

Soil Degradation And Climate Change - A Relationship

Soil degradation plays much a larger role in climate change than was previously suspected. That's because organic matter in soils store

Soil is a major factor in our response to tackling climate change as it is the second largest carbon pool after the oceans.

Soil is essential in the debate on how we tackle climate change, as the release of just a small fraction of the soil carbon stock could offset the savings achieved elsewhere.

For example, in the United Kingdom, losses may amount to more than 13 million tonnes since 1990 (Bellamy, 2008). This estimated loss corresponds to about 10 % of the annual UK industrial carbon emissions (2006), which is approximately the same as the reduction of industrial CO2 emissions in the period 1990–2006.

In general, forest and grassland soils adsorb carbon while cropland is a carbon source.

But, it is clear that tackling climate change cannot be done without a better understanding and management of our soils.

~EEA, 2008. National emissions reported to the UNFCCC

vast amounts of carbon—more than is present in the atmosphere and in all land vegetation combined.

According to the noted geologist Bruce Wilkinson of Syracuse University, heavily cultivated and degraded soils lose their carbon-storing ability as exposed organic matter breaks down.

Over the past half century or so, global soils have lost approximately a hundred billion tons of carbon [in the form of carbon dioxide] to the atmosphere through such exposure. Humans are now the predominant geological force operating on the planet.

Rates of sedimentation and erosion caused by human activities—mainly industrial agriculture—are ten times higher than those attributable to natural processes. On agricultural land, soil is being lost ten times faster than it is being replaced. Humans are rapidly consuming the global soil reservoir. In light of the wasting grains to produce meat and biofuels, this is obviously a very serious change.

19.

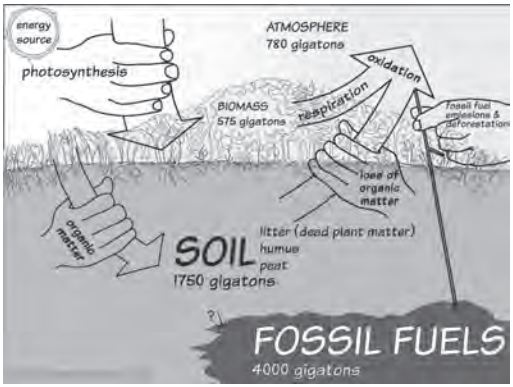
Burying Greenhouse Gases

Under Our Feet

Scientists are trying to figure out what the slight small thing a farmer or agricultural manager could do to increase the amount of carbon retained by their soil.

They have found that making the soil less acidic, changing irrigation patterns, and promoting the formation of certain minerals can make a big difference. Bob Hirshon for AAAS, the Science Society says that some soils could potentially double their carbon content to as much as five percent by weight.

So that means that an acre of soil six inches deep could contain 100,00 pounds of carbon. So a lot of carbon could be stored in an acre of topsoil.



It's hoped that these techniques could help put greenhouse gases safely under our feet. Most people have heard about these

gases coming from cars, factories, and other man-made machines. But they have no idea that modern industrial farming can be the biggest contributor of greenhouse gases.

When industrial farming really took off, about two centuries ago, the earth's soil contained about as much carbon as it could possibly hold. Now that much of that carbon has been released, there's plenty of room to soak it back up.

Bob Hirshon's experiment involves trapping soil in 72 separate tubes. Each tube contains a soil sample that is exposed to slightly different conditions. He has found that soil acidity, the use of common additives, and irrigation patterns all can influence the efficiency of the soil's carbon uptake. And these are changes that farmers could make fairly easily at low cost.

Soil Carbon Sequestration

Plants sequester (remove) carbon from the atmosphere through growth. Carbon dioxide is converted into plant tissue through photosynthesis. After a plant dies, the plant material is decomposed primarily by soil microorganisms, and carbon is released back into the atmosphere through respiration or it is left behind as humus.

So plants and the microorganisms in the soil provide the link between the carbon in the atmosphere and how it can be stored or fixed to biological matter in the soils – this process is called soil carbon sequestration.

20.

The Role of Soil Moisture

On Climate, Weather and Global Warming

Environmental scientists for several decades now have been establishing trends between anthropogenic (human induced) and natural emissions and the global thermal budget by examining carbon cycles and sources and sinks (removal) of atmospheric carbon dioxide.

The global carbon cycle, weather and climate are all heavily influenced by soil moisture. Soil can be both a major source of atmospheric CO2 and a major storage reservoir for carbon with soil moisture being a driving force. In fact, the amount of CO2 emissions from soil is ten times greater than that of human fossil fuel emissions. The CO2 emission from soil is called soil carbon flux or soil respiration and it is the result of bacteria and microorganism in the soil.

Soil moisture, along with temperature, and organic matter concentrations is a major player in the rate of soil respiration and the fate and transport of carbon in the environment. In arid desert regions for example where the soil is very dry, microbial activity in soil decreases, conversely in bogs and swamps where the soil remains saturated with water, anaerobic (without oxygen) conditions occur

which also affects soil respiration. Soil temperature is also important as microbial activity slows with decreasing temperature.

While soil respiration is a major contributor of greenhouse gasses, soil can also be a major reservoir or sink for CO2 by a process called carbon sequestration. Agricultural carbon sequestration is one of the most effective strategies in mitigating the CO2 emissions from fossil fuel combustion.

Not only does soil carbon sequestration provide a net sink for atmospheric concentrations of CO2 but it can increase crop yields, minimize erosion, and save in fuel costs associated with farming.

Large amounts of carbon can be stored in the soil on agricultural land by a practice called conservation tilling. Conservation tilling is a strategy that makes the soil more fertile and includes strategic crop rotations, incorporation of organic manure in the soil, and minimizing the tillage of the fields.

In addition to fertilization, increases in the organic component of soil will increases the porosity allowing the plant roots to have easier access to water. In other words, with conservation tillage, it is possible to take CO2 out of the atmosphere and put in the soil to increase crop yields.

How Does Soil Moisture Affect The Weather?

The global carbon cycle is indeed one of the most interesting and complex phenomenons that effects the climate, the geology and the food chain on Earth and soil moisture is an important player in this process. But how does soil moisture affect the weather?

Soil moisture is important for forecasting both temperature and precipitation. As the temperature rises the evaporation rate of soil

moisture increases. The increased soil moisture evaporation helps cool the ground.

In physics, when things expand they cool their surroundings. Just like human perspiration cools human skin, when water evaporates out of the ground, it expands both in pressure and going from a liquid to a vapor, cooling the day-time temperatures. At night, the opposite holds true.

If the temperature drops below the dew point, condensation or dew will occur and this limits the overnight low temperatures. When water goes from a vapor to a liquid, it goes to a lower energy state thus releasing thermal energy to its surroundings. In other words, things warm up as they condense. Take for example, the daytime and nighttime temperatures of Arizona and Alabama. Both states are at the same latitude but there is a big difference in daytime highs and nighttime lows and soil moisture is the reason why.

There is also a strong correlation between precipitation and soil moisture. If moisture is in the air due to soil moisture evaporation, low pressure systems will condense the moisture and precipitation will occur. If the soil is very dry, there will be less available moisture in the air and it is less likely for precipitation to occur if a low pressure system moves in.

In order to better understand our climate and weather, scientists are studying soil and how it fits in with the ocean in determining global climate changes. In situ measurements of soil moisture are invaluable for countless environmental models.

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21.

Change In Organic Matter In Soil

Changes Atmosphere As A Result

New research shows that we should be looking to the ground, not the sky, to see where climate change could have its most perilous impact on life on Earth.

Scientists at the University of Toronto Scarborough have published research findings in the journal Nature Geoscience that show global warming actually changes the molecular structure of organic matter in soil.

"Soil contains more than twice the amount of carbon than does the atmosphere, yet, until now, scientists haven't examined this significant carbon pool closely," says Myrna J. Simpson, principal investigator and Associate Professor of Environmental Chemistry at UTSC. "Through our research, we've sought to determine what soils

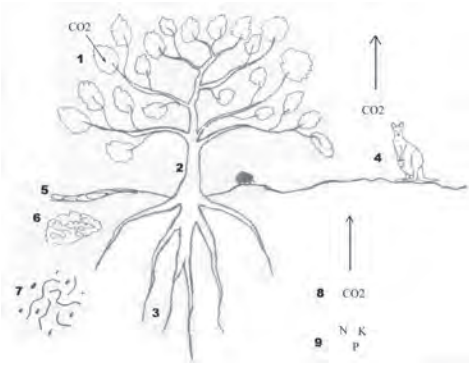
The above-ground component (or above-ground biomass) of pastures and crops store between 2 and 20 tonnes of carbon per hectare.

The above-ground component of plantation forests can store 250 tonnes of carbon per hectare.

To appreciate how valuable the soil is in storing carbon, we need to understand the carbon cycle.

are made up of at the molecular level and whether this composition will change in a warmer world."

Soil organic matter is what makes dirt fertile and able to support plant life – both of which are especially important for agriculture. Organic matter retains water in the soil and prevents erosion. Natural processes of decomposition of soil organic matter provide plants and microbes with the energy source and water they need to grow, and carbon is released into the atmosphere as a by-product of this process. Warming temperatures are expected to speed up this process which will increase the amount of CO2 that is transferred to the atmosphere.



"From the perspective of agriculture, we can't afford to lose carbon from the soil because it will change soil fertility and enhance erosion" says Simpson. "Alternatively, consider all the carbon locked up in permafrost in the Arctic. We also need to understand what will happen to the stored carbon when microbes become more active under warmer temperatures."

Until Simpson's research, scientists didn't know much about soil's molecular composition. Part of the reason is that, from a chemical perspective, soil is difficult to analyze due to its many components, including bacteria, fungi and an array of fresh, partially degraded, or old plant material.

Simpson's team, which includes research collaborators Professors Dudley Williams and Andre Simpson, is uniquely positioned to address this new frontier. The team uses a NMR (Nuclear Magnetic Resonance) facility - the only NMR facility in Canada specifically dedicated to environmental research – to gain a detailed view of soil's molecular structure and reactivity.

In their current study, Simpson's team used an outdoor field experiment in the valley behind the UTSC campus to ensure natural ecosystem processes were preserved. Electrodes warmed the test soil between three and six degrees through winter and summer seasons, over a 14-month period. Throughout the test period, the team analyzed the molecular composition of soil samples.

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22.

Soil Microorganisms and Global Climate Change

In this chapter we aim to examine two aspects of the relationship between soil microorganisms and global climate change. First, we will explore how soil microorganisms contribute to greenhouse gas emissions and then, conversely, we will examine the possible effects that increased temperature and CO2 concentrations in the atmosphere may have on soil microbial processes.

Microorganisms found in the soil are vital to many of the ecological processes that sustain life such as nutrient cycling, decay of plant matter, consumption and production of trace gases, and transformation of metals (Panikov, 1999).

Although climate change studies often focus on life at the macroscopic scale, microbial processes can significantly shape the effects that global climate change has on terrestrial ecosystems. According to the International Panel on Climate Change (IPCC) report (2007), warming of the climate system is occurring at unprecedented rates and an increase in anthropogenic greenhouse gas concentrations is responsible for most of this warming.

Soil microorganisms contribute significantly to the production and consumption of greenhouse gases, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and nitricoxide

(NO), and human activities such as waste disposal and agriculture have stimulated the production of greenhouse gases by microbes.

As concentrations of these gases continue to rise, soil microbes may have various feedback responses that accelerate or slow down global warming, but the extent of these effects are unknown. Understanding the role soil microbes have as both contributors to and reactive components of climate change can help us determine whether they can be used to curb emissions or if they will push us even faster towards climatic disaster.

Microbial Contributions To Greenhouse Gas Emissions

Global soils are estimated to contain twice as much carbon as the atmosphere, making them one of the largest sinks for atmospheric CO2 and organic carbon (Jenkinson and Wild, 1991; Willey et al., 2009). Much of this carbon is stored in wetlands, peatlands, and permafrost, where microbial decomposition of carbon is limited.

The amount of carbon stored in the soil is dependent on the balance between carbon inputs from leaf litter and root detritus and carbon outputs from microbial respiration underground (Davidson and Janssens, 2006).

Soil respiration refers to the overall process by which bacteria and fungi in the soil decompose carbon fixed by plants and other photosynthetic organisms and release it into the atmosphere in the form of CO2. This process accounts for 25% of naturally emitted CO2, which is the most abundant greenhouse gas in the atmosphere and the target of many climate change mitigation efforts.

Small changes in decomposition rates could not only affect CO2 emissions in the atmosphere, but may also result in greater changes to the amount of carbon stored in the soil over decades (Davidson and Janssens, 2006).

Methane is another important greenhouse gas and is 25 times more effective than CO2 at trapping heat radiated from the Earth (Schlesinger and Andrews, 2000).

Not all of the methane produced ends up in the atmosphere however, due to methanotrophic bacteria, which oxidize methane

into CO2 in the presence of oxygen. When methanogens in the soil produce methane faster than can be used by methanotrophs in higher up oxic soil layers, methane escapes into the atmosphere (Willey et al., 2009). Methanotrophs are therefore important regulators of methane fluxes in the atmosphere, but their slow growth rate and firm attachment to soil particles makes them difficult to isolate.

Further exploration of these methanotrophs' nature could potentially help reduce methane emissions if they can be added to the topsoil of landfills, for example, and capture some of the methane that would normally be released into the atmosphere.

Not unlike their role in the carbon cycle, soil microorganisms mediate the nitrogen cycle, making nitrogen available for living organisms before returning it back to the atmosphere. In the process of nitrification (during which ammonia is oxidized to nitrate), microbes release NO and N2O, two critical greenhouse gases, into the atmosphere as intermediates.

Evidence suggests that humans are stimulating the production of these greenhouse gases from the application of nitrogen-containing fertilizers (Willey et al., 2009). For example, Nitrosomonas eutropha is a nitrifying proteobacteria found in strongly eutrophic environments due to its high tolerance for elevated ammonia concentrations.

N-fertilizers increase ammonia concentrations, causing N. eutropha to release more NO and N2O in the process of oxidizing ammonium ions. Since NO is necessary for this reaction to occur, its increased emissions cause the cycle to repeat, thereby further contributing to NO and N2O concentrations in the atmosphere (Willey et al., 2009).

Microbial Responses To Global Climate Change

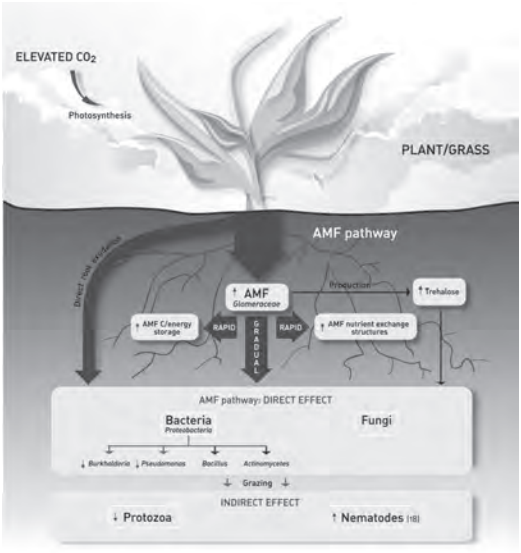
Microbial processes are often dependent on environmental factors such as temperature, moisture, enzyme activity, and nutrient availability, all of which are likely to be affected by climate change (IPCC, 2007). These changes may have greater implications for crucial ecological processes such as nutrient cycling, which rely on microbial activity. For example, soil respiration is dependent

on soil temperature and moisture and may increase or decrease as a result of changes in precipitation and increased atmospheric temperatures. Due to its importance in the global carbon cycle, changes in soil respiration may have significant feedback effects on climate change and severely alter above ground communities. Therefore, understanding the response of soil respiration to climate change is of great importance.

Microbial Response To Increased Temperatures

One of the major uncertainties in climate change predictions is the response of soil respiration to increased atmospheric temperatures (Briones et al., 2004; Luo et al., 2001). Several studies show that increased temperatures accelerate rates of microbial decomposition, thereby increasing CO2 emitted by soil respiration and producing a positive feedback to global warming (Allison et al., 2010).

Under this scenario, global warming would cause large amounts of carbon in terrestrial soils to be lost to the atmosphere, potentially making them a greater carbon source than sink (Melillo et al., 2002). However, further studies suggest that this increase in respiration may not persist as temperatures continue to rise. In a 10-year soil warming experiment, Melillo et al. (2002) show a 28% increase in CO2 flux in the first 6 years of warming when compared to the control soils, followed by considerable decreases in CO2 released in subsequent



years, and no significant response to warming in the final year of the experiment.

The exact microbial processes that cause this decreased long-term response to heated conditions have not been proven, but several explanations have been proposed. It is possible that increased temperatures cause microbes to undergo physiological changes that result in reduced carbon- use efficiency (Allison et al., 2010). Soil microbes may also acclimate to higher soil temperatures by adapting their metabolism and eventually return to normal decomposition rates.

The effects of increased global temperatures on soils is especially alarming when considering the effects it has already begun to have on one of the most important terrestrial carbon sinks: permafrost.

Permafrost is permanently frozen soil that stores significant amounts of carbon and organic matter in its frozen layers. As permafrost thaws, the stored carbon and organic nutrients become available for microbial decomposition, which in turn releases CO2 into the atmosphere and causes a positive feedback to warming (Davidson and Janssens, 2006).

One estimate suggests that 25% of permafrost could thaw by 2100 as a result of global warming, making about 100 Pg of carbon available for microbial decomposition (Davidson and Janssens, 2006; Anisimov et al., 1999).

This could have significant effects on the global carbon flux and may accelerate the predicted impacts of climate change. Moreover, the flooding of thawed permafrost areas creates anaerobic conditions favorable for decomposition by methanogenesis. Although anaerobic processes are likely to proceed more slowly, the release of CH4 into the atmosphere may result in an even stronger positive feedback to climate change (Davidson and Janssens, 2006).

Microbial Response To Increased CO2

Atmospheric CO2 levels are increasing at a rate of 0.4% per year and are predicted to double by 2100 largely as a result of human

activities such as fossil fuel combustion and land-use changes (Lal, 2005; IPCC, 2007).

Increased CO2 concentrations in the atmosphere are thought to be mitigated in part by the ability of terrestrial forests to sequester large amounts of CO2 (Schlesinger and Lichter, 2000). To test this, an international team of scientists grew a variety of trees for several years under elevated CO2 concentrations. They found that high CO2 concentrations accelerated average growth rate of plants, thereby allowing them to sequester more CO2. However, this growth was coupled with an increase in soil respiration due to the increase in nutrients available for decomposition by releasing more CO2 into the atmosphere (Willey et al., 2009).

This suggests that forests may sequester less carbon than predicted in response to increased CO2 concentrations, however more research is needed to investigate this hypothesis.

Soil-Borne Pathogens And Climate Change

According to the IPCC (2007) report, climate change will alter patterns of infectious disease outbreaks in humans and animals. Soil pathogens are no exception: case studies support the claim that climate change is already changing patterns of infectious diseases caused by soil pathogens.

For example, over the last 20 years, 67% of the 110 species of harlequin frogs (Atelopus) native to tropical regions in Latin America have gone extinct from chytridiomycosisthe, a lethal disease spread by the pathogenic chrytid fungus (Batrachochytrium dendrobatidis) (Willey et al., 2009).

Research suggests that mid- to high-elevations provide ideal temperatures for B. dendrobatidis. However, as global warming progresses, B. dendrobatidis is able to expand its range due to increasing moisture and warmer temperatures at higher elevations (Muths et al., 2008).

This expansion exposes more amphibian communities in previously unaffected or minimally affected areas, specifically at

higher elevations, to chytridiomycosisthe. As seen in the case of Atelopus harlequin frogs, the spread of soil pathogens due to climatic changes can significantly affect life at the macro scale and ultimately lead to species extinction.

Conclusion

The complexity of microbial communities living below ground and the various ways they associate with their surroundings make it difficult to pinpoint the various feedback responses that soil microbes may have to global warming. Whether a positive feedback response results, in which microbial processes further contribute to climate change, or whether a negative feedback response slows its effects, it is clear that microbes can have a huge impact on future climate scenarios and ecosystem-level responses to climate change.

Soil respiration plays a pivotal role in these effects due to the large amount of CO2 and CH4 emissions produced during respiration, the reliance of carbon stocks in soils on rates of respiration, and the initial sensitivity of soil respiration to increased atmospheric temperatures.

Further studies in long-term feedback effects of soil respiration on climate change can contribute to our understanding of the overall impacts of climate change, including the ability of terrestrial forests to uptake excess CO2 from the atmosphere.

As we attempt to mitigate greenhouse gas emissions and adapt to predicted climate change effects, turning towards microscopic life that lies below the surface can perhaps help us to become better equipped for future changes at the macroscopic and even global scale.

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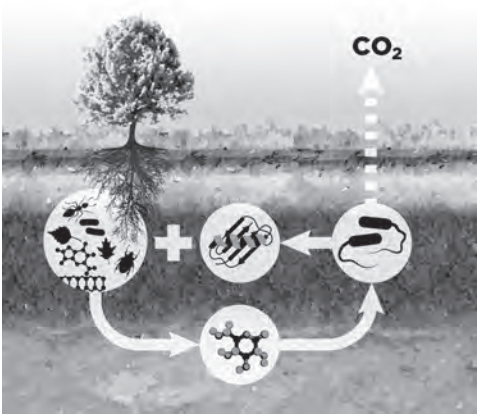
23.

Soil carbon

Soil carbon is the generic name for carbon held within the soil, primarily in association with its organic content. Soil carbon is the largest terrestrial pool of carbon, containing 2,200 gigatonnes (Gt) of it.

Humans increasingly influence the size of this pool. Soil carbon plays a key role in the carbon cycle, and thus it is important in global climate models.

Although the figure is frequently being revised upwards with new discoveries, over 2,700 gigatonnes (Gt) of carbon is stored in soils worldwide, which is well above the combined total of atmosphere (780 Gt) or biomass (575 Gt), most of which is wood.



Soil carbon is the last major pool of the carbon cycle. The carbon that is fixed by plants is transferred to the soil via dead plant matter, including dead roots, leaves, and fruiting bodies. This dead organic matter creates a substrate which decomposes and

respires back to the atmosphere as carbon dioxide or methane, depending on the availability of oxygen in the soil. Soil carbon is also oxidized by combustion and returned to the atmosphere as carbon dioxide.

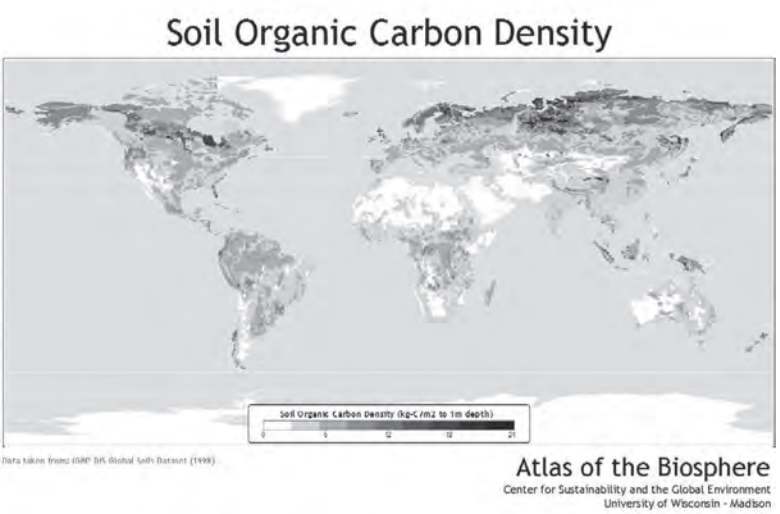
Soil carbon is primarily composed of biomass and non-biomass sources. Biomass carbon includes various bacteria and fungi.

Soil Carbon And Soil Health

It is widely accepted that the carbon content of soil is a major factor in its overall health. Soil carbon improves the physical properties of soil. It increases the cation-exchange capacity (CEC) and water-holding capacity of sandy soil, and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. It prevents nutrient leaching, and is integral to the organic acids that make minerals available to plants. It also buffers soil from strong changes in pH.

Losses Of Soil Carbon

The exchange of carbon between soils and the atmosphere is a significant part of the world carbon cycle. Carbon, as it relates to the organic matter of soils, is a major component of soil and catchment



health. Several factors affect the variation that exists in soil organic matter and soil carbon; the most significant has, in contemporary times, been the influence of humans and agricultural systems.

Although exact quantities are difficult to measure, human activities have caused massive losses of soil organic carbon. Modern industrial methods of agriculture are all highly injurious to the health of soil and contribute without exception to losses of soil carbon. Grazing management that exposes soil (through either excessive or insufficient recovery periods) can also cause losses of soil organic carbon.

It has long been encouraged that farmers adjust practices to maintain or increase the organic component in the soil. On one hand, practices that hasten oxidation of carbon (such as burning crop stubbles or over-cultivation) are discouraged; *on the other hand, incorporation of organic material (such as in manuring) has been encouraged.* Increasing soil carbon is not a straightforward matter; it is made complex by the relative activity of soil biota, which can consume and release carbon and *are made more active by the addition of nitrogen fertilizers.*

Carbon And Soil Health

Much of the contemporary literature on soil carbon relates to its role, or potential, as an atmospheric carbon sink to offset climate change. Despite this emphasis, a much wider range of soil and catchment health aspects are improved as soil carbon is increased. These benefits are difficult to quantify, due to the complexity of natural resource systems and the interpretation of what constitutes soil health; nonetheless, several benefits are proposed in the following points:

Reduced Erosion, Sedimentation

Increased soil aggregate stability means greater resistance to erosion; mass movement is less likely when soils are able to retain structural strength under greater moisture levels.

Greater Productivity

Healthier and more productive soils can contribute to positive socio-economic circumstances.

Cleaner Waterways, Nutrients And Turbidity

Nutrients and sediment tend to be retained by the soil rather than leach or wash off, and are so kept from waterways.

Water Balance

Greater soil water holding capacity reduces overland flow and recharge to groundwater; the water saved and held by the soil remains available for use by plants.

Climate Change

Soils have the ability to retain carbon that may otherwise exist as atmospheric CO2 and contribute to global warming.

Greater Biodiversity

Soil organic matter contributes to the health of soil flora and, accordingly, the natural links with biodiversity in the greater biosphere.

Forest Soils

Forest soils constitute a large pool of carbon. Anthropogenic activities such as deforestation cause releases of carbon from this pool, which may significantly increase the concentration of greenhouse gas (GHG) in the atmosphere.

Tropical deforestation represents nearly 25 percent of total anthropogenic greenhouse gas emissions worldwide. Not only deforestation, but forest degradation and changes in land management practices can also cause releases of carbon from soil to the atmosphere.

The government of Tanzania—together with the Food and Agriculture Organization of the United Nations and the financial

support of the government of Finland—have implemented a forest soil carbon monitoring program to estimate soil carbon stock, using both survey and modelling-based methods.

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24.

The Importance Of Soil Carbon Conservation

Following an extensive examination of the literature on soil-stored carbon published over the last 60 years a group of researchers from the University of Sussex, University of Cambridge and from Italy have collated estimates of global soil organic carbon stocks.

This first comprehensive overview of the world's largest terrestrial pool of carbon highlights the importance of soil carbon conservation in mitigating global climate change.

The study, published recently in the journal Carbon Management, draws attention to the extent to which changing the way land is used contributes to rising atmospheric CO2.

The study's leader, Dr Jörn Scharlemann, previously at the United Nations Environment Programme World Conservation Monitoring Centre in Cambridge and now Reader in Ecology & Conservation in the School of Life Sciences at the University of Sussex, described his team's

findings as a call to arms. He says: "It's really surprising—although the first soil carbon map we found dates back to the 1950s, we probably still know more about the moon than about soil carbon."

Accurate knowledge about the quantity of carbon stored in soils is important because the greenhouse gas CO2 is often emitted when land use is changed, either through human activities such as agriculture or natural forces such as flooding. Carbon emissions resulting from changes in land use and land cover are the second largest source of human-caused carbon emissions to the atmosphere after emissions from fossil fuel combustion.

To date, however, most policies aimed at reducing CO2 emissions have focused on carbon stored in plants, despite the fact that more carbon is stored in soils than in plants. The majority of carbon stored in the soil is the result of millennia of decomposition of organic matter. Estimates of global organic soil carbon stocks are uncertain, and carbon emissions from land use and land cover change remain the least understood component of the global carbon cycle.

"We're trying to discourage carrier bag use."

The accuracy of distributional data for global soil organic carbon stocks is not consistent across the globe, however. While some regions, including China and Europe, have been mapped at a high resolution, the majority of the data comes from coarse resolution soil maps dating back to the 1970s.

Furthermore, existing maps usually only provide data on carbon stocks to a depth of 1 m. In parts of the world, however, organic

soils can be up to 11 m deep, with the result that these soils contain more organic carbon than is indicated on the distribution maps.

Dr Scharlemann says: "Climate change models are currently using soil carbon estimates that vary by an order of magnitude. We're creating scenarios of climate change, and basing decisions on these scenarios, even though the input data are actually really uncertain."

The researchers call for existing estimates of global organic carbon stocks to be improved through the collection of more data on soil profiles, sampling soil carbon to greater depths, and the use of standardised sampling and modelling techniques. In recent years, new techniques, such as remote sensing, have become available, which could be used to estimate the amount of organic matter in soils.

Policies designed to reduce emissions of carbon have not fully considered the effects of land use and land cover change on soil organic carbon stocks and their emissions, despite significant losses of soil carbon. In some cases, for example, up to 50 per cent of soil organic carbon is lost when native vegetation is converted to cropland.

The researchers urge policy and decision makers to recognise the importance of soil organic carbon in the global carbon cycle and in climate change mitigation. "Policy makers need to take soil carbon into account, but to do this they need better information on the total amount of carbon stored in soils and where it's distributed," says Dr Scharlemann.

Sources:

Maggie Clune, Feb 12, 2014

Global soil carbon: understanding and managing the largest terrestrial carbon pool. Jörn PW Scharlemann, Edmund VJ Tanner, Roland Hiederer, Valerie Kapos. Carbon Management, February 2014, Vol. 5, No. 1, Pages 81-91 , DOI: 10.4155/cmt.13.77

Bellamy P.H., 2008. UK losses of soil carbon – due to climate change? Presentation given at the Conference "Climate Change – can soil make a difference?" – 12 June 2008

25.

Soil Organic Carbon

Soil organic carbon, the major component of soil organic matter, is extremely important in all soil processes. Soil organic carbon refers to all the different carbon compounds found in soils that are, or were previously, a living organism.

Soil Organic Matter

Soil organic matter is generally divided into three components:

1. Particulate Material

Particulate material refers to the bits and pieces of plant material, or material that is available to soil organisms for decomposition.

Soil organisms break down particulate matter to create humus, which is the final product of the decaying process; it will break down no further.

2. Humus

Humus is important for binding soil particles together. It improves the water and nutrient holding capacity of soils, and these are essential for plant growth. Humus stores or sequesters carbon for decades, or even centuries.

3. Charcoal

Charcoal is the result of incomplete burning of plant material or fossil fuels. It is believed to be biologically and chemically unreactive compared with other soil organic matter components.2 This means that the carbon stays locked in the charcoal in the soil and isn't readily released or taken up by soil organisms.

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Reference:

Guo LB & Gifford RM, 'Soil carbon stocks and land-use change: A meta analysis'.

Johnson, DW 1992, 'Effects of forest management on soil carbon storage', Water, Air and Soil Pollution.

26.

Healthy Soil

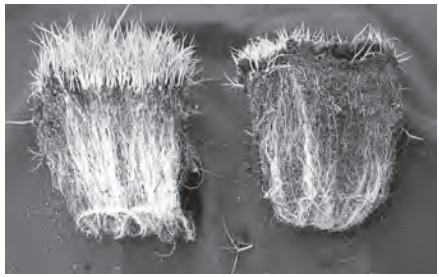
Its Characteristics

Healthy Soil Stores Carbon Better

Healthy soils with a high organic carbon content contribute to the following soil characteristics, which are important for soil fertility and climate correction:

Nutrient Availability: Decomposition of soil organic matter releases nitrogen, phosphorus and a range of other nutrients for plant growth.

Soil Structure And Soil Physical Properties: Soil organic carbon promotes a healthy soil structure by holding the soil particles together, thereby improving soil physical properties such as water-holding capacity, water infiltration, gaseous exchange, root growth and ease of cultivation.



Biological Soil Health: Soils contain microscopic plants and animals which live between, and feed on, the many soil particles. Soil organic matter plays an important role in the soil food web

by controlling the number and types of soil inhabitants. These inhabitants serve important functions such as cycling nutrients, making nutrients available for other organisms, assisting root growth, assisting plant nutrient uptake, creating burrows, and even suppressing crop diseases.

Buffer For Toxic And Harmful Substances: Soil organic matter can lessen the effect of harmful substances, for example toxins such as heavy metals, by acting as a buffer. Heavy metal toxins can bond very tightly to soil particles, preventing their release into waterways where contamination affecting the food chain may occur. Soil organic matter also increases the absorption of pesticides, thus reducing the amount of chemicals that may enter groundwater.

Reference

Canadian Journal of Forest Research, vol. 30

Inputs, yield, and soil organic matter', Soil Science Society of America Journal, vol. 58

Carbon Farm Gas Calculator

Industry & Investment NSW - Primary Industries has developed an online calculator that can assist farmers to calculate greenhouse gas contributions from their farm operations.

27.

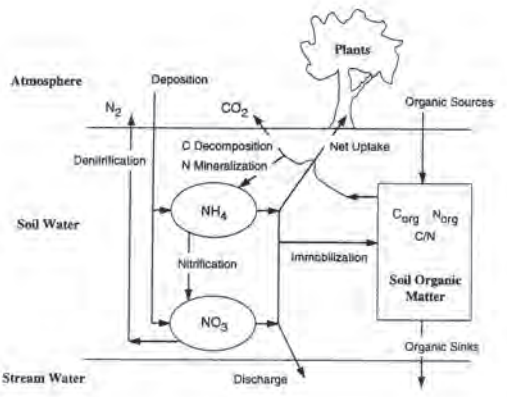
To Increase Soil Organic Carbon

Some Common Practices

Some of the management practices farmers are implementing which can increase soil organic carbon stocks while improving production output include the following:

Applying organic fertiliser to overcome nutrient deficiencies, thereby enhancing plant growth and, consequently, litter inputs. Applying organic amendments - recycled organics such as manures, biosolids, composts and char.

Selecting cropping, forest or pasture systems that will maximise plant growth. Each species has a different carbon allocation strategy that results in a different pattern, rate, quality and quantity of organic carbon input to the soil. Mixed-species planting (i.e. two species) can maximise biomass production where the two species allow one another to grow better in each other's presence. Examples are:



nitrogen-fixing species such as acacia planted with eucalypts;[1] lupin with pine;[2] and clover with pasture grasses.[3] These combinations commonly produce greater growth outputs when planted together than if a single species is planted on its own.

Minimising cultivation disturbance, to reduce mineralisation and erosion losses. This minimising of soil disturbance will conserve soil carbon, particularly in erodible soils.

Modifying grazing management to maintain pasture cover, thereby minimising erosion losses and maximising organic input to soil.

In later chapters, this subject is dealt with in greater detail.

References:

1. Bauhus, J, Khanna, PK & Menden, N 2000, 'Aboveground and belowground interactions in mixed plantations of Eucalyptus globulus and Acacia mearnsii', , pp. 1886–1894 IN: Fairweather, H. and Cowie, A., 2007. Climate change research priorities for NSW primary industries. NSW Department of Primary Industries, Orange, NSW.

2. Beets, PN & Madgwick, HAI 1988, 'Above-ground dry matter and nutrient content of Pinus radiata as affected by lupin, fertilizer, thinning, and stand age', New Zealand Journal of Forestry Science, vol.18, pp. 43–64 IN: Fairweather, H. and Cowie, A., 2007. Climate change research priorities for NSW primary industries. NSW Department of Primary Industries, Orange, NSW.

3. Ledgard, SF 1991, 'Transfer of fixed nitrogen from white clover to associated grasses in swards grazed by dairy-cows, estimated using N-15 methods', Plant and Soil, vol. 131, pp. 215–223 IN: Fairweather, H. and Cowie, A., 2007. Climate change research priorities for NSW primary industries. NSW Department of Primary Industries, Orange, NSW.

Section - IV

Saving The World

One Farm At A Time

Regenerative Organic Agriculture

A Down-to-Earth Solution to Climate Change

28.

The Solution Is Farming

The Way It Has Been Done Since Time Immemorial

We are at the most critical moment in the history of our species, as man-made changes to the climate threaten humanity's security on Earth. But there is a technology for massive planetary geo-engineering that is tried and tested and available for widespread dissemination right now. It costs little and is adaptable to local contexts the world over. It can be rolled out tomorrow providing multiple benefits beyond climate stabilization.

The solution is farming.

Simply put, we could sequester more than 100% of current annual CO2 emissions with a switch to widely available and inexpensive organic management practices, which we term "regenerative organic agriculture."

A Tried And Trusted Method

Two Way Benefit : Feeding The Growing Human Population And Repairing Our Damaged Ecosystem

"What are you, some kind of wise guy? Of course it's organic."

Regenerative organic agriculture for soil-carbon sequestration is tried and true: Humans have long farmed in that fashion, and there is nothing experimental about it. What is new is the scientific verification of regenerative agricultural practices. Excess carbon in the atmosphere is surely toxic to life, but we are, after all, carbon-based life forms, and returning stable carbon to the soil is a tonic that can support ecological abundance.

One Stop Solution

Taken together, the wealth of scientific support for regenerative organic agriculture has demonstrated that these practices can comfortably feed the growing human population while repairing our damaged ecosystem:

If management of all current cropland shifted to reflect the regenerative organic model as practiced at the research sites included in the white paper, we could potentially sequester more than 40% of annual emissions.

If all global pasture was managed using a regenerative model, an additional 71% could be sequestered.

Even if modest assumptions about soil's carbon sequestration potential are made, regenerative agriculture can easily keep annual emissions to within a desirable range.

Essentially, passing the 100 percent mark means a drawing down of excess greenhouse gases, resulting in the reversal of the greenhouse effect.

One Arrow Two Cougars - Healing Our Land And Ourselves

Today there are farmers and agricultural scientists in every corner of the world committed to and excited about the results of regenerative organic agriculture's potential in mitigating both climate issues and food insecurity, and the specific research needs have been well documented. Now is the time to harness cutting-edge technological understanding, human ingenuity and the rich history of farmers working in tandem with the wisdom of natural ecosystems.

Now is the time to arrive at a stable climate by way of healing our land and ourselves—through regenerative organic agriculture.

Ample food grains can be produced through agricultural enterprises, and profuse supplies of milk, yogurt and ghee can be arranged through cow protection. Abundant honey can be obtained if the forests are protected. Unfortunately, in modern civilization, men are busy killing the cows that are the source of yogurt, milk and ghee, they are cutting down all the trees that supply honey, and they are opening factories to manufacture nuts, bolts, automobiles and wine instead of engaging in agriculture. How can the people be happy?

~ Srila Prabhupada (Srimad Bhagavatam 5.16.25)

29.

Synthetic Chemicals And Industrialization Of Farming

Death Of A Small Planet

Correcting Agriculture Is An Answer To Climate Chaos

The Rodale Institute, an independent/nonprofit agricultural research institute widely recognized as the birthplace of the organic movement in the U.S., has announced in April 2014 the launch of a global campaign to generate public awareness of soil's ability to reverse climate change, but only when the health of the soil is maintained through organic regenerative agriculture. The campaign calls for the restructuring of our global food system with the goal of reversing climate change through photosynthesis and biology.

The white paper, Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming, is the central tool of the campaign. The white paper states that "We could sequester more than 100% of current annual CO2 emissions with a switch to widely available and inexpensive organic management practices, which we term 'regenerative organic agriculture.'"

"The purpose of our work is singular; we are working to create a massive awakening," says Mark Smallwood, executive director of Rodale Institute.

"Our founder, J.I. Rodale, had a vision so ambitious that many people wrote him off at the time. Almost 75 years later, the organic movement is exploding with growth and fierce determination. But the stakes are much higher in 2014. J.I. saw that agriculture was heading in a dangerous direction by way of the wide-spread adoption of the use of synthetic chemicals and the industrialization of farming. He attempted to prevent that transition. We no longer have the luxury of prevention. Now we are in the dire situation of needing a cure, a reversal. We know that correcting agriculture is an answer to climate chaos, and that it hinges on human behavior. The massive awakening itself is the cure. The future is underfoot. It's all about healthy soil."

Regenerative organic agriculture is comprised of organic practices including (at a minimum): cover crops, residue mulching, composting and crop rotation. Other biological farming systems that use some of these techniques include ecological, progressive, natural, pro-soil and carbon farming.

The Rodale Institute supports its claims by explaining that if sequestration rates attained by the cases cited inside the white paper were achieved on crop and pastureland across the globe, regenerative agriculture could sequester more than our current annual carbon

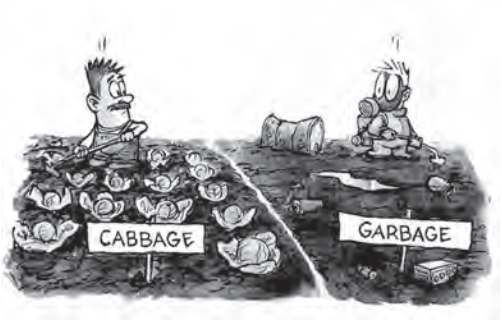
dioxide emissions. Even if modest assumptions about soil's carbon sequestration potential are made, regenerative agriculture can easily keep annual emissions to within the desirable range necessary if we are to have a good chance of limiting warming to 1.5°C by 2020.

"The white paper is to encourage new research, new policy and the rapid expansion of regenerative agricultural methods," said Smallwood.

"The media campaign brings the broader vision to the public much faster. The idea is to stoke the public outcry that already exists and to validate those who demand these changes be made now. By engaging the public now, they build the pressure necessary to prevent this call to action from sitting on the desks of scientists and policy-makers, or worse yet, being buried by businesspeople from the chemical industry. We don't have time to be polite about it."

Below are three excerpts exemplifying the call to action set forth in the white paper:

Organically managed soils can convert carbon from a greenhouse gas into a food-producing asset. It's nothing new, and it's already happening, but it's not enough. This is the way we have to farm, period.



There's a technology for massive planetary geo-engineering that's tried and tested and available for widespread dissemination right now. It costs little and is adaptable to localities the world over. It can be rolled out tomorrow providing multiple benefits beyond climate stabilization. It's photosynthesis.

The solution is farming like life on Earth matters; farming in a way that restores and even improves on the natural ability of the microbiology present in healthy soil to hold carbon. This kind

of farming is called regenerative organic agriculture and it is the solution to climate change we need to implement today.

Since its founding in 1947, the Rodale Institute has been committed to groundbreaking research in organic agriculture, advocating for policies that support farmers, and educating people about how organic is the safest, healthiest option for people and the planet. The Rodale Institute is home to the Farming Systems Trial, America's longest-running side-by-side comparison of chemical and organic agriculture. Consistent results from the study have shown that organic yields match or surpass those of conventional farming. In years of drought, organic corn yields are about 30 percent higher. This year, 2013, marks the 33rd year of the trial. New areas of study at the Rodale Institute include rates of carbon sequestration in chemical versus organic plots, new techniques for weed suppression and organic livestock.

The white paper also cites 75 studies from peer-reviewed journals.

30.

Organic Farming

Is It A Viable Way To Feed The Planet?

Often the most frequently asked question is whether farming without synthetic pesticides and genetically modified organisms is really a viable way to feed the planet. Rodale Institute believes it can do that and better.

In the longest-running study of its kind, Rodale's Farming Systems Trial compares organic farming with conventional farming, by farming neighboring plots just as organic farmers and traditional farmers would — that means its organic farming plot utilizes techniques like crop rotation and cover crops while the conventional plot uses common synthetic pesticides

"Don't worry, it's *organic*."

Michel Cavigelli, a research soil scientist at the USDA's Agricultural Research Service, which has a slightly different 19-year side-by side study, says his research also shows that organic soil has higher carbon content than conventional soil.

and genetically modified organisms. Both organic and conventional fields were divided into tilled and no-till areas to reflect that farmers use both practices.

The findings show that organic farming yields are lower than conventional in the first few years, while conventional crops do better in the first years than they do later on. Over time the production equals out and with organic outperforming conventional farming production in years of drought (organic corn yields 31% more than conventional corn during drought).

"When you start to grow using organic methods and products, the soil is still depleted," Executive Director Mark Smallwood says. "That's why the yield initially isn't as high." He says that organic

According to Steve Savage, a Stanford- trained biologist and organic critic who consults for the agriculture industry, "There's nothing wrong in principal [with the organic production findings] but in general there are the practical aspects of this being scaled up." He sites issues such as attaining enough cow manure and that many farmers rent their land, which disincentives efforts to build up the soil.

farming betters the soil over time, while chemical farming depletes it. "If the soil is weak, so too will be the plants," he adds.

Additionally, the study shows that organic farming requires less energy and emits less greenhouse gas. Paired with higher price points at market, the study shows organic produce to be more profitable.

31.

Climate Chaos

It's A Grocery Store Issue, A Dinner Plate Issue

By Rodale Institute

Climate change, or more accurately climate chaos, hits each and every one of us in an incredibly intimate way--right in the stomach. From the global breadbasket to our nation's farm fields to pantries everywhere, our food supply is at risk. Climate chaos isn't just an environmental issue. It is a grocery store issue, a dinner plate issue, a filling-our-bellies issue.

Instead of picturing graphs and thermometers and melting ice caps when we think about climate chaos, we should be seeing rolling fields of grain, vines of succulent tomatoes, lazily grazing livestock, and the faces of our neighbor farmers, rural and urban alike, struggling and failing due to droughts, floods, superweeds, and other extreme consequences of a changing climate.

There is hope and we're standing on it. Our food supply and our farmers, both in the eye of the storm and so often contributors to climate change, could also be our salvation.

Changing the way we farm can reverse climate change.

Researchers have called it biological, ecological, progressive, pro-soil, and carbon farming, among others. Add these terms on top of organic, local, free-range, sustainable, natural, fair trade, and so forth, and you have a recipe for mental overload.

There is one thing farms that fight climate chaos have in common. There is one sure thing that turns a farm from a contributor to climate change into a solution for it: healthy soil.

In all conversations on how to avoid the devastating implications of climate change, carbon sequestration is always heralded as humanity's saving grace. "People are left to pray for a yet undiscovered 'technological messiah' to undo the damage, for our political will is paralyzed;" if we could just figure out how to do it, we can save the world. But we already have the tools and knowledge that we need, and the solution is more elegant than just our technology alone. By altering how we interact with the Earth in our agriculture, we can begin to reverse the damage already done while improving the lives of billions of people across the globe, many in places already feeling the heat of climate change.

~ Rodale Institute

Human society was organic before it had a definition, and back then, soil was at the very heart of what we did.

Regenerative organic agriculture is a holistic approach to growing food that encourages continual on-farm innovation for environmental, social, economic, and spiritual well-being. It is an umbrella that includes practices that often fall separately under certified "organic," "fair trade," "local," and other labels, and aims to continuously improve soil, food, human health, communities, and the wider world.

Climate chaos seems overwhelming and unsolvable, but we can begin reversing the destructive trend today. The answer is farming.

Agriculture is the noblest profession. It makes society happy, wealthy, healthy, honest, and spiritually advanced for a better life after death. The vaisya community, or the mercantile class of men, take to this profession. In Bhagavad-gita the vaisyas are described as the natural agriculturalists, the protectors of cows, and the general traders. When Lord Sri Krsna incarnated Himself at Vrndavana, He took pleasure in becoming a beloved son of such a vaisya family. Nanda Maharaja was a big protector of cows, and Lord Sri Krsna, as the most beloved son of Nanda Maharaja, used to tend His father's animals in the neighboring forest. By His personal example Lord Krsna wanted to teach us the value of protecting cows. Nanda Maharaja is said to have possessed nine hundred thousand cows, and at the time of Lord Sri Krsna (about five thousand years ago) the tract of land known as Vrndavana was flooded with milk and butter. Therefore God's gifted professions for mankind are agriculture and cow protection.

~ Srila Prabhupada (Light of Bhagavata, verse 9)

32.

Regenerative Organic Agriculture and Climate Change

A Down-to-Earth Solution to Global Warming

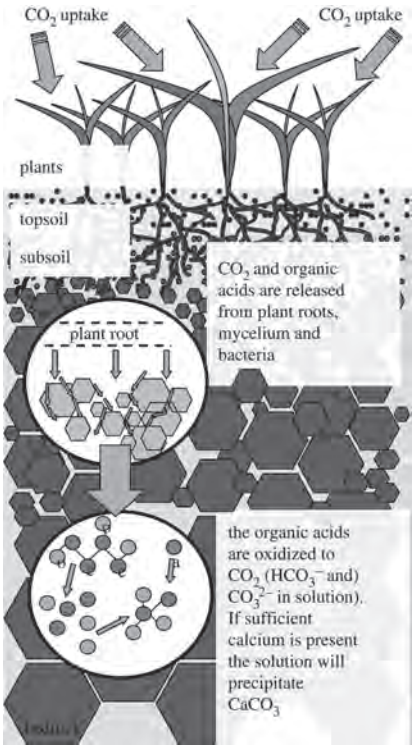
A White Paper By Rodale Institute

We are at the most critical moment in the history of our species, as manmade changes to the climate threaten humanity's security on Earth. In 2012, total annual global emissions of greenhouse gases were approximately 52 GtCO2e

(GtCO2e refers to gigatons CO2 released into the atmosphere. A gigaton is equal to 1 billion tons).

These emissions must soon drop to a net of 41 GtCO2e if we are to have a feasible chance of limiting warming to 1.5°C, above which point we dare not pass.

The key term in the above paragraph is "net." Gross greenhouse gas emissions come from numerous manmade sources. The resulting climate chaos has begun to modify our planet in ways that are not fully understood, leading to natural emissions that add to the complexity of the challenge. If we continue to attack the climate crisis solely from the direction of reducing gross manmade emissions, we will be forced to confront all the bewildering complexity of climate chaos. We will also be forced to battle carbon pumps everywhere – industrial, agricultural, the transportation sector – and from every direction on the globe. We will be forced to ask what countries should bear what responsibility, what industries should bear what portion of the blame and burden, and who should pay for the sacrifices we tremble to imagine? This daunting challenge is posed by trying to solve the problem by addressing only the "pump," and it has led to international bickering, incoherence, and inaction. People are left to pray for a yet undiscovered "technological messiah" to undo the damage, for our political will is paralyzed.



All this flows from the failure to look beyond the source of the problem, namely, the swarming carbon pumps that endlessly contaminate our atmosphere. The purpose of this paper is to redirect the discussion from the "swarm" to the "simple." We suggest an obvious and immediately available solution – put the carbon back to work in the terrestrial carbon "sinks" that are literally right beneath our feet. Excess carbon in the atmosphere is surely toxic to life, but we are, after all, carbon-based life forms, and returning stable carbon to the soil can support ecological abundance.

Simply put, recent data from farming systems and pasture trials around the globe show that we could sequester more than 100% of current annual CO2 emissions with a switch to widely available and inexpensive organic management practices, which we term "regenerative organic agriculture." These practices work to maximize carbon fixation while minimizing the loss of that carbon once returned to the soil, reversing the greenhouse effect.

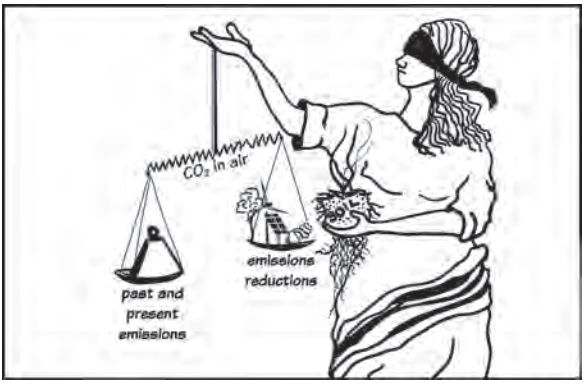
Regenerative organic agriculture for soil-carbon sequestration is tried and true: Humans have long farmed in that fashion, and there is nothing experimental about it. What is new is the scientific verification of regenerative agricultural practices. Farming trials across the world have contrasted various forms of regenerative and conventional practices and studied crop yield, drought impact, and carbon sequestration.

Some of these studies are in their third decade of data, such as this Institute's Farming Systems Trial, and there are important fresh looks such as in the new Tropical Farming Systems Trial ("TFST") on the Caribbean slope of Costa Rica. The TFST is exactly the type of research needed for us to understand the full sequestration potential of regenerative agriculture, and Rodale Institute is pleased to be collaborating there with local researchers associated with Finca Luna Nueva and EARTH University. Taken together, the wealth of scientific support for regenerative organic agriculture has demonstrated that these practices can comfortably feed the growing human population while repairing our damaged ecosystem.

This scientific support has also led the United Nations Commission on Trade and Development ("UNCTAD") to issue, in September, 2013, it report "Wake Up Before It's Too Late," a powerful call for the return to these sustainable practices.

Developing a comparable set of global farming system trials designed to more specifically measure carbon sequestration is our best hope for demonstrating the power of regenerative organic agriculture to help solve the climate equation. At the same time, these trials will act as hubs of skills incubation and support networks for farmers already working in, or transitioning to, regenerative organic models.

Today there are farmers and agricultural scientists in every corner of the world committed to and excited about the results of regenerative organic agriculture's role in reversing both climate issues and food insecurity, and the specific research needs have been well documented. Now is the time to harness cutting-edge technological understanding, human ingenuity and the rich history of farmers working in tandem with the wisdom of natural ecosystems. Now is the time to arrive at a stable climate by way of healing our land and ourselves - through regenerative organic agriculture.



This paper is the massive awakening.

A Zero Carbon Economy Devoid Of Fossil Fuels - A Dream

Solving the long-term climate equation means getting to a zero carbon economy devoid of fossil fuels. It is widely acknowledged that we are not going to arrive at a new low-carbon economy any

time soon; the technologies, markets, political and social structures needed to shift the world's economies are not materializing quickly enough.[1] In the decades it will take to decarbonize the economy, an unacceptable level of warming will become locked in.[2]

With each passing year of inaction, hope for our planet's future becomes harder and harder to rally. We are on a trajectory of too little too late. If we wait, our only hope for the future lies in yet-to-be-discovered technological fixes coupled with the loss of whole cultures and species. The numbers are so sobering that untested technologies for carbon capture and storage have in short order gone from unsafe, outlandish whims to pressing societal needs: bioengineering the human body has even entered the climate conversation.

Hope - Right Beneath Our Feet

And yet, there is hope right beneath our feet. There is a technology for massive planetary geo-engineering that is tried and tested and available for widespread dissemination right now. It costs little and is adaptable to local contexts the world over. It can be rolled out tomorrow providing multiple benefits beyond climate stabilization. The solution is farming. Not just business-as-usual industrial farming, but farming like the Earth matters. Farming like water and soil and land matter. Farming like clean air matters.

Life should be conducted in such a way that our necessities of life may come not with great effort, easily, easily. We should not encumber ourself, our life, living policy, in an encumbered way. Then our spiritual progress will be hampered. The modern society has practically encumbered the whole human activities, and therefore they have no time for spiritual culture. You see? But the conception of Vedic civilization was that people used to be satisfied on agricultural produce and for three months working during rainy season. So they get some agriculture produce and they used to eat the whole year. So nine months they were free to advance in spiritual culture and only three months they used to work for accumulating their foodstuff.

~ Srila Prabhupada (Bhagavad-gita 2.46-47 -- New York, March 28, 1966)

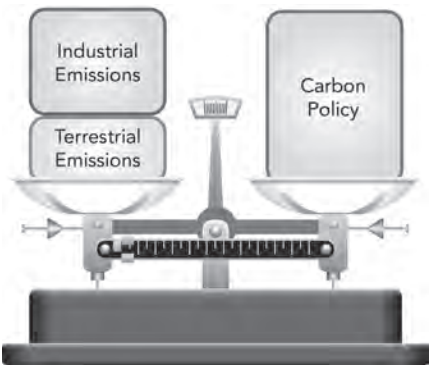
Farming like human health, animal health and ecosystem health matters. Farming in a way that restores and even improves on soil's natural ability to hold carbon. This kind of farming is called regenerative organic agriculture and it is the short-term solution to climate change we need to implement today.

We don't have to wait for technological wizardry: regenerative organic agriculture can substantially mitigate climate change, now.

On-farm soil carbon sequestration can potentially sequester all of our current annual global greenhouse gas emissions of roughly 52 gigatonnes of carbon dioxide equivalent (~52 GtCO2e).

Indeed, if sequestration rates attained by exemplar cases were achieved on crop and pastureland across the globe, regenerative agriculture could sequester more than our current annual carbon dioxide (CO2) emissions. Even if modest assumptions about soil's carbon sequestration potential are made, regenerative agriculture can easily keep annual emissions to within the desirable lower end of the 41-47 GtCO2e range by 2020, which is identified as necessary if we are to have a good chance of limiting warming to 1.5°C.[2]

Industrial Agriculture - Part of The Problem



But agriculture as it is practiced today across most of the world is not part of the solution; it is, instead, part of the problem. Rather than mitigating climate change, it is a net producer of greenhouse gas emissions both directly through conventional farming practices that deplete soil carbon stocks while emitting nitrous oxide (N2O), and indirectly through land-use change.[3]

In addition, the intensification of livestock production and rice paddy agriculture has exacerbated release of the greenhouse gas methane (CH4). Since the dawn of farming, most agricultural soils

have lost from 30% to 75% of their original soil organic carbon.[4] With the widespread modernization of farming in the mid-20th century, contemporary agricultural practices, such as synthetic nitrogen fertilization, tillage, monocropping, and yield-based management systems, have accelerated the depletion of soil carbon stocks adding to the human-induced, or anthropogenic, atmospheric load of N2O and CO2.[3,5]

Over the past decade, these direct agricultural emissions have increased about one percent a year, reaching 4.6 Gt CO2 yr in 2010, or about 10% of total annual emissions.[6] Direct emissions are not the whole picture. The food system at large, including feed, fertilizer and pesticide manufacture, processing, transportation, refrigeration and waste disposal, accounts for 30% or more of total annual global greenhouse gas emissions.[7]

Improved management of agricultural land with known, low-cost practices has the potential to both reduce net greenhouse gas emissions and to act as a direct CO2 sink.[3,8]

Moving agriculture from a source of carbon pollution to a potential carbon sink is in everyone's best interest. Agriculture that sequesters carbon is also agriculture that addresses our planetary water crisis, extreme poverty, and food insecurity while protecting and enhancing the environment now and for future generations.[9] Regenerative organic agriculture is the key to this shift. It is the climate solution ready for widespread adoption now.

What Is Regenerative Organic Agriculture?

Regenerative organic agriculture improves the resources it uses, rather than destroying or depleting them. It is a holistic systems approach to agriculture that encourages continual on-farm innovation for environmental, social, economic and spiritual wellbeing.[10]

Robert Rodale, son of American organic pioneer J.I. Rodale, coined the term 'regenerative organic agriculture' to distinguish a kind of farming that goes beyond simply 'sustainable.' Regenerative organic agriculture "takes advantage of the natural tendencies of ecosystems to regenerate when disturbed. In that primary sense it is distinguished from other types of agriculture that either oppose or ignore the value of those natural tendencies." [11] Regenerative organic agriculture is marked by tendencies towards closed nutrient loops, greater diversity in the biological community, fewer annuals and more perennials, and greater reliance on internal rather than external resources.[11] Regenerative organic agriculture is aligned with forms of agroecology practiced by farmers concerned with food sovereignty the world over.[12,13]

Changing farming practices to organic, regenerative and agroecological systems can increase soil organic carbon stocks, decrease greenhouse gas emissions,[14] maintain yields,[15,16] improve water retention and plant uptake,[17] improve farm profitability,[16] and revitalize traditional farming communities[18] while ensuring biodiversity and resilience of ecosystem services.[17,19] Regenerative organic agriculture is also integral to the climate solution.

The Reversal Capability of Regenerative Organic Agriculture

If management of all current cropland shifted to reflect the regenerative model as practiced at the Iranian or Egyptian sites, we could potentially sequester more than 40% of annual emissions (an estimated 21 GtCO2 each year). If, at the same time, all global pasture was managed to a regenerative model, an additional 71% (~37 GtCO2) might be sequestered,[1] bringing us into an annual negative emissions scenario rapidly.

Table 1: Reported carbon sequestration from trials around the world

Place	Crop And Practices	Reported Carbon Sequestration	Extra-polation To All Global Cropland
U.S.[21]	Corn-Vegetable-Wheat | Organic, tillage, composted manure, legume cover crop	2.36 Mg C ha^{-1} yr^{-1}	12 Gt CO2 yr^{-1}
Egypt	Peanuts | Biodynamic, compost, irrigation	4.10 Mg C ha^{-1} yr^{-1}	21 Gt CO2 yr^{-1}
Iran[23]	Corn | No-till, manure, hand-weeding	4.10 Mg C ha^{-1} yr^{-1}	21 Gt CO2 yr^{-1}
Thailand[24]	Unreported Crop | Organic	6.38 Mg C ha^{-1} yr^{-1}	32 Gt CO2 yr^{-1}
Global[25]	Pasture | Improved grass species	3.04 Mg C ha^{-1} yr^{-1}	37 Gt CO2 yr^{-1}

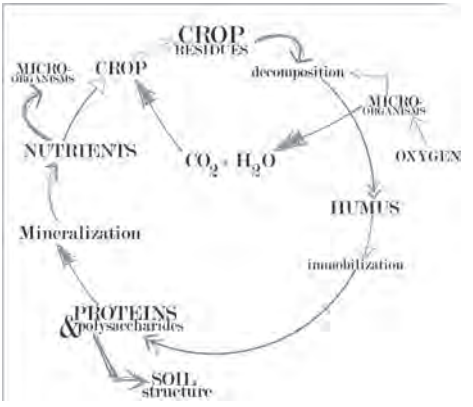
If we extrapolate to half rather than all of global pasture and cropland, transition to regenerative modes of production may sequester 55% (29 GtCO2) of 2012 annual emissions. Even if only

half of all available cropland shifted to regenerative agriculture and no changes are made in pasture management, we would meet the 2020 threshold of 41 GtCO2e that makes many scenarios for limiting warming to 1.5°C feasible.

These scenarios present technical sequestration potential as a heuristic that allows us to grasp the latent power of regenerative agriculture. Investing in human capacity, knowledge infrastructure and safe, known agricultural techniques can produce the change we need while providing myriad co-benefits to farmers and eaters everywhere.

Regenerative Organic Agricultural Practices That Sequester Carbon

Sequestration means maximizing the carbon dioxide pulled from the atmosphere by plant growth and minimizing the loss of that carbon once it is stored in soil. In technical terms it is the net difference between atmospheric carbon fixed through photosynthesis and carbon respired from all ecosystem constituents. Achieving on-farm carbon sequestration must be made an explicit management goal[26] but there are longstanding regenerative management practices that are already proven soil carbon builders.



Soil Food Web

In practical terms, regenerative organic agriculture is foremost an organic system refraining from the use of synthetic pesticides and inputs, which disrupt soil life, and fossil-fuel dependent nitrogen fertilizer, which is responsible for the majority of anthropogenic N2O emissions. It is a system designed to build soil health.

Regenerative organic agriculture is comprised of organic practices including (at a minimum): cover crops, residue mulching, composting and crop rotation. Conservation tillage, while not yet widely used in organic systems, is a regenerative organic practice integral to soil- carbon sequestration.

Although many of these practices are most associated with organic farming, they are recommended management practices for all farms because they build soil organic matter, which has far reaching benefits for plant health and farm sustainability.[15] These practices minimize biota disturbance and erosion losses while incorporating carbon rich amendments and retaining the biomass of roots and shoots, all of which contribute to carbon sequestration by photosynthetic removal and retention of atmospheric CO2 in soil organic matter.[3,27] These practices result from management decisions regarding cropping, amendments and tillage within the wider scope of a systems approach to farming that rejects synthetic inputs.

When coupled with the management goal of carbon sequestration, these practices powerfully combine with the spirit of organic agriculture to produce healthy soil, healthy food, clean water and clean air using inexpensive inputs local to the farm. This long-term integrated approach builds soil health, providing nutrients, pest

and disease resistance. Farming becomes, once again, a knowledge intensive enterprise, rather than a chemical and capital-intensive one.

While the ensuing discussion of practices is helpful for understanding how regenerative organic agriculture can sequester atmospheric CO2, these practices are not intended to be judged or implemented in isolation. Regenerative agriculture is, above all else, a holistic systems approach to appropriate farming in context. However, since the agricultural sciences most often hinge on reductionism,[28] data for specific practices and discrete suites of practices are mobilized here to help us understand the mechanisms at work in soil carbon sequestration.

The Problem of Bare Soil

Bare soil is detrimental to carbon sequestration and to soil health in general. Bare soil is an indicator of practices that are not maximizing atmospheric CO2 removal nor minimizing soil carbon losses.

Agricultural soils that are left fallow or are heavily tilled are exposed to wind and water leading to erosion of the carbon-rich topsoil. Fallow land also fails to accumulate biomass carbon that it would otherwise by continuously growing plants. Tilled, exposed, eroded soils lead to the breakdown of soil aggregates, allowing formerly stable soil carbon to be released as a greenhouse gas (CO2).[29,30] Tillage further undermines soil carbon sequestration by debilitating the growth of mycorrhizal fungi, which are important for long-term sequestration through their role in aggregate formation. Reducing or eliminating tillage, using cover crops and enhancing crop rotations ensure that land will not be left bare and that soil carbon will be fixed, rather than lost.

Conservation Tillage

A recent research review found that almost all studies to-date show that switching to conservation tillage not only improves soil structure, but also reduces carbon dioxide emissions and contributes

to increases in soil organic carbon.[31] But, reduced or no-till is only a boon to greenhouse gas emissions reduction when it is practiced within organic systems: the soil carbon gains achieved under conventional no-till agriculture are countervailed by the greater area-scaled N2O emissions from nitrogen fertilization.[34,35] In addition, synthetic nitrogen fertilization increases microbial respiration of CO2 while phosphorus fertilization suppresses the growth of root symbiotic fungi, which are important for long-term soil carbon storage.[5,75]

While no-till organic remains a marginal practice, its dependence on heavy cover cropping for weed suppression,[32] coupled with the benefits of organic management in general, have been shown to increase soil organic carbon by nine percent after two years and 21 percent six years after conversion to organic no-till.[32,33] No-till systems can best reverse the trend of soil organic carbon loses in agriculture when they are complemented by cover-cropping and enhanced crop rotations.[36,37]

Cover Crops

At least half of the cropland carbon is fixed aboveground in plant biomass,[38] making cover cropping and residue retention clear necessities for carbon sequestration. Cover crops can be temporary crops planted between main cash crops (often promoted for overwintering in temperate climates), nutrient catch-crops, or perennial mulches. Cover crops increase soil carbon, reduce nitrogen leaching and discourage wind and water erosion.[8] A wide range of additional benefits accrue with the use of cover crops: reduced weed pressure, decreased water runoff, improved soil structure and water infiltration, reduced evaporation and, in legume systems, atmospheric nitrogen fixation, which is often advantageous to the subsequent main crop.[39] Due to their longer leaf stage and more complex root systems, perennial cover crops, or living mulches, are an additional boon to soil carbon sequestration.[40]

Enhanced Crop Rotations

Moving crop rotations away from monoculture with fallow and towards polyculture with no fallow increases soil biodiversity and sequesters carbon.[37] For instance switching a wheat-fallow rotation to a wheat-sunflower or wheat-legume rotation was found to increase soil organic carbon stocks significantly,[37] and a continuous barley system more than doubled soil carbon stocks compared to a barley-fallow system.[41] Integrating seeded grass species as cover crops, living mulches, or in rotation is a powerful means of increasing soil carbon due to the deep, bushy root systems of many of these perennials.[25,37] Both cover cropping and enhanced rotations result in continuous cover, which also increases soil microbial biomass carbon by ensuring available energy and root hosts for bacteria and fungi.[42]

Residue Retention

Cover crops also play a significant role in soil sequestration when their plant and root residues are retained rather than removed or burned.[43] These residues are the forerunners to soil organic matter.[8] Residue removal, whether of the main crop or a cover crop, has become common for the production of bio-energy. This practice depletes soil organic matter.[44] Conversely, retention of crop residue, which is common in no-till systems, is a significant driver of soil carbon accumulation.[36]

Compost

Plants, or a portion of plant residue, from cover crops or main crops can also be composted to boost soil health and soil carbon sequestration. Composting is the controlled aerobic decomposition of organic materials such as plants, animals or manure. The resultant compost is a desirable soil amendment; it increases soil biodiversity and microbial biomass with a concomitant rise in biological services, such as nutrient cycling, disease suppression and soil structure enhancement.[45]

These soil benefits translate into greater soil health and productivity while reducing water or fertilizer needs.[46] The benefits

are significant and accrue quickly: after only one application season of amending with compost, soil organic carbon and aggregate stability increase significantly compared with non-amended soils.[47]

Amending with composted manure in particular shows great promise for soil carbon sequestration. In a 10-year trial, fields with a crop rotation utilizing composted dairy manure sequestered more than two metric tons of carbon (Mg C) per hectare per year, while the paired conventional farming system lost carbon.[21] In addition, when compost replaces synthetic nitrogen fertilizer, plants grow more roots, fixing more atmospheric carbon in the process.[23]

Complexity

The holistic interaction of management practices, soil conditions and climatic circumstances is more important than any one practice's potential contribution to soil carbon sequestration. For instance, while it is clear that conventional-chemical, tilled monocrop systems actually contribute to greenhouse gas emissions, similar monocrop systems that do not use tillage have very low rates of carbon sequestration.[36] Tilled organic systems fair better on soil quality indicators relating to carbon sequestration, including soil organic carbon, than similarly tilled non-organic systems.[26]

The interaction of the suite of management practices with the specific soil and climate plays a significant role in organic matter stability. For example, soils with greater clay content tend to stabilize

It has been estimated that Australia's cropping soils have lost a substantial amount of carbon, estimated to be 1050 Mt (megatonnes), following the introduction of intensive cropping. This signifies that there is significant potential to increase carbon stocks in these carbon-poor soils by improving land management practices. It is believed that over time, a change in land use from forest or grassland to cropping generally leads to a loss of 50% or more in soil carbon.

~ 'The effects of clearing and cropping on the organic reserves and biomass of tropical forest soils', Soil Biology and Biochemistry, vol. 8,

carbon more readily than sandy soils.[48,49] An illustrative case found that while only half of the carbon from composted poultry manure remained in the soil at five months, with the addition of clay to the manure, half of the carbon remained in the soil after two years.[48] This inherent complexity leads to a great deal of uncertainty in extrapolating results from one farm to another farm or in garnering consistent results attributable to a specific practice. It also highlights the need for research on comparable suites of practices in different soils and climates.

Timeframe for Sequestration

The goal of regenerative organic farming for carbon sequestration is not only to increase soil organic matter content through the practices highlighted here, but also to ensure the longevity of that carbon in the soil. Since the carbon cycle is dynamic and the study of soil in-situ is difficult, the factors influencing retention time of carbon in soil are inherently complex and not yet fully understood.[50]

However, rapid, stable carbon sequestration under the conditions encouraged by regenerative agriculture is possible. Fungi, depth in the soil profile and recent understandings regarding the humic fraction of soil all play a role. An Iranian trial of no-till, low-input corn production showed that regenerative methods using composted manure were able to raise soil carbon by 4.1 metric tons per hectare per year in just two years compared to .01 metric tons for the paired tilled system using synthetic fertilizer.[23]

Mycorrhizal Fungi

While the understanding of soil carbon stabilization mechanisms is evolving, it is clear that soil biota play an important role here. In general, there is a positive relationship between abundance of fungal biomass and soil carbon.[53] Recent research on carbon sequestration in boreal forests suggests that root-associated, or mycorrhizal, fungi are predominantly responsible for fixing soil carbon, and for fixing it over long time periods to such an extent that it is consequential to the global carbon cycle.[54]

Arbuscular mycorrhizal fungi are root-symbiotic fungi that secrete a protein called glomalin; this particular fungi-root partnership and its glomalin are largely responsible for creating persistent, stable soil aggregates that protect soil carbon from being lost as CO2.[55,56] The fungal hyphae actually increase in abundance under elevated atmospheric CO2 conditions.[57,58] When the hyphae deteriorate, glomalin remains as a stable form of organic carbon that is held in the soil for decades.[56] This initial shorter-term stabilization provides the time for organic matter to create bonds with metals and minerals, the resultant organo-mineral or organo-metal complexes can remain in the soil for millennia.[27]

Since mycorrhizal fungi need root-partners to survive, farming strategies that include perennial plantings, conservation tillage, and plants with long, bushy root systems, encourage the long-term stabilization of carbon in soils.[59,60] Likewise, promising effects have been shown for inoculation of soils with fungi, especially in cases where heavy tillage has destroyed the native population of mycorrhizal fungi. Arbuscular mycorrhizal fungi can be introduced to seedlings through inoculations that are easily prepared on-farm.[61,62]

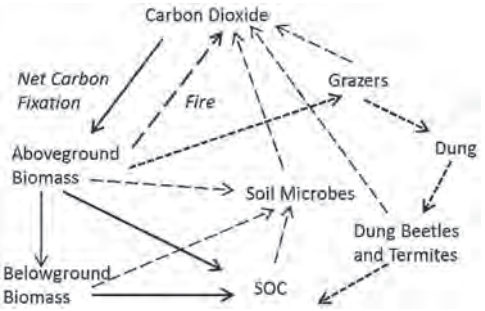
Depth

It is likely that current data sets underestimate soil organic carbon stocks in organically managed systems because soil carbon is often measured at plow depth when recent findings suggest that more than half of the soil organic carbon stocks are likely in the

20-80cm depth.[14] Beyond 30cm in the soil profile, the age of carbon increases continuously, much of it persisting for thousands of years.[63] How carbon acts in this subsoil range is poorly understood, but increasing rooting depth,[55] application of irrigated compost[63] (compost tea), choosing deep rooted grass-legume cover crops[64] and encouraging earthworm abundance[65] are all promising pathways for introducing carbon to depths where it is likely to remain stable over very long periods.

Timescales

All soil carbon is in flux and the degree to which it is protected in undisturbed soil aggregates or separated from soil life largely determines how long it is held in soil.[27] But additions of fresh organic matter can, under the right circumstances, be effectively sequestered quickly. For instance, in tropical soils, results suggest that two years of organic management may significantly and consistently enhance microbial biomass carbon.[66] Even more promising, after only one cropping season, soil that had received 67Mg per hectare of compost and beef cattle manure had statistically significantly higher organic carbon levels.[47]



A long-term biodynamic desert trial in Egypt confirmed that soil carbon sequestration is greatest in the earlier years of transition to organic practices. In a first year plot 4.1 metric tons of carbon per hectare were sequestered, whereas the average over 30 years was 0.9 metric tons per hectare.[22] These results suggest that soil carbon can be built quickly enough to result in a rapid drawdown of atmospheric CO2 upon transition to regenerative agricultural systems. However, it is probable that soils have unique carbon saturation points,[27,67] suggesting that soil carbon sequestration is

a remedy that will allow time for implementation of additional long-term solutions to the climate predicament.

The Question of Yields

No discussion promoting the widespread transition to regenerative organic agricultural systems would be complete without mentioning yields. Yields are often touted as the reason why we cannot scale up organic and regenerative systems, but evidence suggests otherwise.

Metanalyses of refereed publications show that, on average, organic yields are often lower than conventional.[15] But the yield gap is prevalent when practices used in organic mimic conventional,[68] that is, when the letter of organic standards is followed using an input mentality akin to conventional chemical-intensive agriculture. Actual yields of organic systems, rather than agglomerated averages, have been shown to outcompete conventional yields for almost all food crops studied including corn, wheat, rice, soybean and sunflower.[15]

Importantly, yields under organic systems are likely to be more resilient to the extreme weather accompanying climate change. As found in the long-running Rodale Institute Farming System Trial, in drought years, yields were consistently higher in the organic systems. For instance, organic corn yields were 28% to 34% higher than conventional.[16]

What's more, the continued use of the trope that 'we will soon need to feed nine billion people' as justification for seeking ever greater yields is duplicitous. Hunger and food access are not yield issues. They are economic and social issues which, in large part, are the result of inappropriate agricultural and development policies that have created, and continue to reinforce, rural hunger.[69]

We currently overproduce calories. In fact, we already produce enough calories to feed nine billion people. Hunger and food access are inequality issues that can be ameliorated, in part, by robust support for small-scale regenerative agriculture.[9]

Proving Grounds: Multiple, Global, Farming System Trials

As we have well learned from the charged climate debates, science evolves, contradicts itself and is certainly not definitive. The science of soil carbon sequestration is no different than climate science in this regard and it suffers doubly from a relative dearth of serious inquiry into organic, regenerative and agroecological systems due to the formidable economic and political constraints at work in contemporary agriculture and agricultural sciences research.[69–71]

Questions abound over the technical and feasible potential of soil carbon sequestration when metanalyses are modeled regionally or globally.[14,67,72,73] Additionally, any claims of soil carbon sequestration must be balanced with a whole farm lifecycle analysis that considers, for instance, the origin and alternative fates of compost substrates and the role of livestock in organic systems.[65]

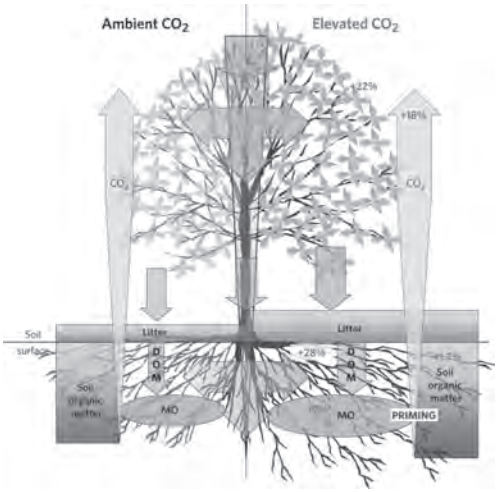
The range of potential and level of debate is a clear call for a new model of farming systems research: trials designed explicitly to study the carbon sequestration potential of regenerative agriculture as compared to conventional agriculture. Regenerative suites of practices can be studied alongside business-as-usual practices in different climates, soils and within different farming-culture contexts. The need for these data is pressing: scant peer-reviewed

literature on soil carbon sequestration is available for most of the world's continents, including Africa, Central and South America and large swaths of Asia.[65]

The first of these global farming trials was initiated in 2013 on the Caribbean slope of Costa Rica, conducted by local researchers associated with Finca Luna Nueva and EARTH University. This Tropical Farming Systems Trial is partnered with and supported by Rodale Institute's long- standing U.S. based Farming Systems Trial. The Tropical Farming Systems Trial is designed to rigorously test and compare the carbon sequestration potential, total carbon footprint, yields and economics of conventional, organic and biodynamic farming systems.

Developing a set of global farming systems trials designed specifically to measure carbon sequestration is our best hope for quantitatively and definitively demonstrating the power of regenerative agriculture to begin reversal of the climate equation.

These trials will be designed with international comparison in mind while remaining grounded in local knowledge and farming cultures. At the same time these trials will act as hubs of skills incubation and support networks for farmers already working in, or transitioning to, regenerative models. There are committed, enthusiastic farmers and agricultural scientists in every corner of the world and the specific research needs have been well documented.[65,67,74] Now is the time to mobilize



resources and seize this opportunity to change course, before it is too late.

Beyond Sustainable

We are at a critical moment in the history of our species. Climate change is a monumental opportunity to change course and move into a future that embraces life, a future bent on encouraging health, a future where clean air and clean water is available to all. In so many ways, a fundamental restructuring of how we cultivate our food is at the heart of this shift. Widespread regenerative organic agriculture will be built on supports that necessarily also support rural livelihoods, strengthen communities and restore health the world over. Regenerative organic agriculture is our best hope for creating a future we all want to live in, and a future our children will be happy to inherit.

Soil carbon sequestration through regenerative agriculture is a known, proven, technical, remedy to global warming: it gives humanity the necessary time to decarbonize. By investing in

multiple, global farming system trials we can both provide the needed data to support widespread transition directly work towards that transition through incubating skills and providing a global support network, on the ground, for farmers to lead the evolution to regenerative systems.

This positive, hopeful vision for our future addresses many of our most pressing societal issues. It is a vision of agriculture that Robert Rodale urged us toward almost three decades ago:[10]

Our hope is that the period of sustainability will not be sustained for more than 10 or 15 years but that we will move beyond that to the idea of regeneration, where what we are really doing with the our Land is not only producing our food but regenerating, improving, reforming to a higher level our landscape and our Spirit.

Nearly 30 years later, the specter of climate change has provided an unparalleled opportunity to harness cutting-edge technological understanding, human ingenuity and the rich history of farmers working in tandem with the wisdom of natural ecosystems to arrive at a stable climate by way of healing our land and ourselves. Let's get going.

Why you are making big, big plan of big, big factories? You take to this process for your economic problem solved." Krsna advises, krsi-go-raksya-vanijyam vaisya-karma svabhava-jam [Bg. 18.44]. This is the agriculture, cow protection, trade. No industry. Krsna never says industry, trade. Trade means... Suppose here we are attempting to grow food stuff. So after eating for ourselves, if there is excess, then we can take this food grains or anything which we have produced to a place where there is need. That is called trade. Trade in exchange also. There is exchange. That is also trade. So that is recommended by Krsna.

~ Srila Prabhupada (Bhagavad-gita 3.25 -- Hyderabad, December 17, 1976)

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33.

Modern Industrial Agriculture

And Climate Chaos

Modern agriculture, food production and distribution are major contributors of greenhouse gases: Agriculture is directly responsible for 14 per cent of total greenhouse gas emissions, and broader rural land use decisions have an even larger impact. Deforestation currently accounts for an additional 18 per cent of emissions.

In this context, a historical perspective needs to be considered: Dr. Rattan Lal, Professor of Soil Science at Ohio State University, has calculated that over the last 150 years, 476 billions of tonnes of carbon has been emitted from farmland soils due to inappropriate farming and grazing practices, compared with 'only' 270 Gt emitted from of burning of fossil fuels. A more frequently quoted figure is that 200 to 250 Gt of carbon have been lost from the biosphere as a whole in the last 300 years. Whatever the correct figure, these reductions of 'living carbon potential' have resulted from

Deforestation
Biodiversity Loss
Accelerated Soil Erosion
Loss Of Soil Organic Matter
Salinisation Of Soils
Costal Water Pollution And
Acidification Of The Oceans

Land use changes can also significantly contribute to climate change. Large scale changes such as deforestation, soil erosion or machine-intensive farming methods may all contribute to increased carbon concentrations in the atmosphere. Soil erosion by water, wind and tillage affects both agriculture and the natural environment. Soil loss, and its associated impacts, is one of the most important (yet probably the least well-known) of today's environmental problems.

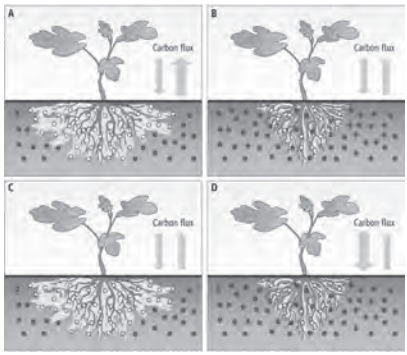
34.

The Agricultural Causes of Climate Change

Modern Agriculture accounts for a substantial portion of greenhouse gases. Agriculture is responsible for 20 percent of the total greenhouse gas emissions globally, primarily through the production of nitrous oxide and methane. While the quantity of agricultural emissions is less than the carbon dioxide emissions produced from the burning of fossil fuels, they are far more potent. Nitrous oxide is 23 times more damaging to the earth's atmosphere than carbon dioxide, and methane is 310 times more damaging.

Nitrogen Fertilizer As A Major Source Of Nitrous Oxide.

Nitrous oxide accounts for 60 percent of the greenhouse gas emissions from agriculture. While nitrous oxide is a natural product of microbial processes, the high concentration of the gas from the use of nitrogen fertilizer is a major contributor to global warming.



Livestock - Factory Farming

Anthropogenic livestock produces more greenhouse gas than all the cars in the world.

An artificial diet of corn and other things leads to enteric fermentation, a natural process that occurs in animals during the digestion of food, producing methane as a byproduct. Methane is then released into the atmosphere through animal flatulence and belching. Methane is also produced during the decomposition of manure when it is deposited in ponds, tanks and pits. Due to the tremendous number of cattle bred for beef and dairy products, high concentrations of methane are released into the atmosphere. The Food and Agriculture Organization of the United Nations (FAO) estimates that livestock are responsible for 18 percent of greenhouse gas emissions, which is a higher percentage share than transportation.

Deforestation

Forests are destroyed to make room for grazing, growing feed for livestock and crops for human consumption. Global meat industry is mainly responsible for the rapid deforestation around the globe.

Forests are fundamental to the earth's ecosystem, performing many vital functions that help perpetuate the water cycle, provide habitats for millions of species and protect soil integrity. They also clean the air by absorbing greenhouse gasses. Deforestation is the result of rapidly expanding agriculture land use. Seventy percent of the Amazon forest has been cleared for grazing livestock and growing crops, thereby reducing the absorption of greenhouse gasses. This has increased the speed and severity of global warming.

Fossil Fuel Consumption

Agriculture is responsible for significant carbon dioxide emissions as well as nitrous oxide and methane.

In the United States alone, over 33 million cattle and nine million dairy cows are produced annually, as well as 60 million pigs and nearly nine billion chickens. The use of gasoline and diesel powered farming equipment, machinery and transport vehicles to sustain this level of operation is responsible for eight percent of the greenhouse gas emissions from agriculture.

Source:

Lisa Dorward, eHow Contributor

Schroeder, 'Can intensive forest management increase carbon storage in forests?', Environmental Management, vol. 15

'Land use, land-use change, and forestry: a special report of the Intergovernmental Panel on Climate Change', Cambridge University Press

"Human society needs only sufficient grain and sufficient cows to solve its economic problems. All other things but these two are artificial necessities created by man to kill his valuable life at the human level and waste his time in things which are not needed."

~Srila Prabhupada

(Srimad Bhagavatam 3.2.29)

Section-V

The World's Soil Is In Trouble

Deterioration of The Hidden World Under Our Feet

Deteriorating Soil Is The World's Most Critical Issue

35.

Top Soil And Survival of Civilization

Top Soil, The Most Important And The Most Neglected National Resource

Soil is the Earth's fragile skin that anchors all life. Soil is the most important national asset and its conservation deserves the highest national priority. Any civilization is founded on topsoil and soil erosion destroys it. Policy makers are blissfully unaware of this fact and national policies are being made in boardrooms as parliaments take a backseat.

But this accomplishment has come with a big price tag. Scorched with chemicals, topsoil is getting destroyed and land is turning into a desert. Soil, deprived of farmyard manure, is in revolt.

Industrial civilization in last 200 years has been using up resources which took nature millions of years to create. This rate of resource usage is unsustainable. Unless we change our course, we are in for some serious trouble in the near future. There are concerns expressed about resources like fossil fuels, marine life, forest covers and mineral wealth but top soil escapes the attention of one and all. Policy makers and scientists don't know much and don't care either about this critical resource.

If Earth Were An Apple

Top soil is the most important national resource because this is where our food comes from. Importance of top soil preservation can be understood by the example of an apple.

Let's think of Earth as an apple. Now Cut the apple into quarters. Set the three 'water' sections aside' and the remaining quarter represents the total land surface.

Slice the land (the remaining 1/4) in half, lengthwise. This 1/8 represents the half of the Earth's surface that is inhospitable to people and to crops: the polar regions, deserts, swamps, and high or rocky mountains.

Set that 1/8 aside and take the other 1/8 piece. This 1/8 represents the other half of the Earth's surface. These are the areas on which people can live, but cannot necessarily grow food.

Slice this 1/8 crosswise into four equal pieces. Set aside 3 pieces, i.e., 3/32 parts. These 3/32 represent land on which people can live, but cannot grow food. Some of it was never arable because it's too rocky, wet, cold, steep or has soil too poor to produce food. Some of it used to be arable but isn't any longer because it's been developed—turned into cities, suburbs, highways, etc., so it can no longer be farmed. Governments have earmarked other areas, such as parks, nature preserves and other public lands to remain undeveloped forever.

So, only 1/32 of the Earth's surface has the potential to grow the food needed to feed all of the people on Earth.

Now carefully peel the 1/32 slice of Earth.

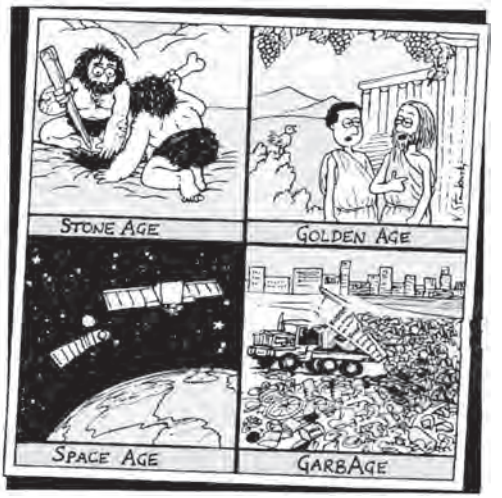
This tiny bit of peel represents the topsoil, the dark, nutrient-rich soil that holds moisture and feeds us by feeding our crops.

Thus any layman can understand the vital importance of topsoil as a rare and non-renewable resource which sustains all life on the planet. It is considered non-renewable because it takes centuries, if not millenniums to form one centimeter of top soil whereas it can be squandered in a matter of few decades.

Soil - Seen Better Days

But in modern age, we can not be more neglectful of this precious resource. For thousands of years, farmers took utmost care of their fields.

In 1909, American agronomist F.H. King toured China, Korea and Japan, studying traditional fertilization, tillage and general farming practices. He wrote his observations and findings in Farmers of Forty Centuries, Or Permanent Agriculture in China, Korea, and Japan (1911, published shortly after his death by his wife). King lived in an era preceding synthetic nitrogen fertilizer production and before the use of the internal combustion engine for farm machinery, yet he was profoundly interested in the challenge of farming the same soils in a 'permanent' manner, hence his interest in the agricultural practices of ancient cultures. In recent years, his book became an important organic farming reference.



In contrast, modern farming practices are utterly destructive as far as top soil is concerned. *All over the world, more than seven and a half million acres of soil has been degraded.* That's larger than the U.S. and Canada combined. What remains is ailing as a result of compaction, erosion and salination making it near impossible to plant and adding to greenhouse gases and air pollution. Soil degradation is putting the future of the global population is at risk according to a National Geographic article by Charles Mann. Civil

unrest in Latin America, Asia and Africa have been attributed to a lack of food and affordable food as a result of poor soil.

Experts estimate that by 2030 the Earth's population will reach 8.3 billion. Farmers will need to increase food production but not much soil remains. Of course, we already grow enough food but most of it is going to animal farming, rather than feeding humans.

Soil Conservation - Deserves The Highest National Priority

Why should the leaders of countries today commit their government and their people to a national programme of soil conservation?

The answer is that soil takes many years to create, but it can be destroyed in almost no time at all. With the loss of soil goes man's ability to grow food crops and graze animals, to produce fibre and forests. It is not enough to describe the soil as a country's greatest source of wealth; it is more than that; it is a country's life. And in one country after another today, the soil is washing or blowing away.

Soil Is A Complex Mixture

Soil covers most of the land surface of the earth in a thin layer, ranging from a few centimeters to several metres deep. It is composed of rock and mineral particles of many sizes mixed with water, air, and living things, both plant and animal, and their remains.

On our scale of time, soil formation is extremely slow. Where the climate is moist and warm, it takes thousands of years to form just a few centimetres of soil. In cold or dry climates, it takes even longer, or soil may not form at all. While soil is technically a renewable resource, its slow rate of formation makes it practically irreplaceable.

Soil is a dynamic mixture, forever changing as water comes and goes and plants and animals live and die. Wind, water, ice, and gravity move soil particles about, sometimes slowly, sometimes rapidly. But even though a soil changes, the layers of soil stay much the same during one human lifetime unless they are moved or scraped, or ploughed by man.

Soil Teems With Life

It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources to humans.

All soil is full of life, and good soils are teeming with it. Plants and animals help keep the soil fertile. Plant roots tunnel through the soil and break it up, and decaying plants form humus. Burrowing animals mix the soil; the excrete of animals contribute nutrients and improve soil structure.

Besides the soil's more obvious inhabitants, which include rodents, insects, mites, slugs and snails, spiders, and earthworms, there are countless microscopic residents, some helpful to man and his crops, some harmful.

Good soils seem to hold the greatest populations of bacteria. Almost without exception, bacteria are involved in basic enzyme transformations that make possible the growth of higher plants, including our food crops. From man's point of view, bacteria may well be the most valuable of the life forms in soil.

Chemical reactions occur in the soil as a result of exchange of positive ions, or cations. More exchanges take place in clay soils than in any other type. These chemical reactions are also essential to plant growth and development and are a good index of soil fertility.

Soil - The Earth's Capital

By Sir Albert Howard, 1940

Since the Industrial Revolution the processes of growth have been speeded up to produce the food and raw materials needed by the population and the factory. Nothing effective has been done to replace the loss of fertility involved in this vast increase in crop and animal production. The consequences have been disastrous.

Half of the topsoil on the planet has been lost in the last 150 years. Agriculture has become unbalanced: the land is in revolt: diseases of all kinds are on the increase: in many parts of the world Nature is removing the worn-out soil by means of erosion.

We are destroying the earth's capital—the soil; we need to be aware of the consequences of this.

The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture. In the ordinary processes of crop production fertility is steadily lost: its continuous restoration by means of manuring and soil management is therefore imperative.

Transformation Of A Farmer Into A Bandit

By Sir Albert Howard, 1940

The wheel of life is made up of two processes—growth and decay. The one is the counterpart of the other. The processes of decay which round off and complete the wheel of life can be seen in operation on the floor of any woodland. It can be seen how the mixed animal and vegetable wastes are converted into humus and how the forest manures itself.

Such are the essential facts in the wheel of life. Growth on the one side: decay on the other. In Nature's farming a balance is struck and maintained between these two complementary processes.

The only man-made systems of agriculture—those to be found in the East—which have stood the test of time have faithfully copied this rule in Nature. It follows therefore that the correct relation between the processes of growth and the processes of decay is the first principle of successful farming. Agriculture must always be balanced. If we speed up growth we must accelerate decay. If, on the other hand, the soil's reserves are squandered, crop production ceases to be good farming: it becomes something very different.

The farmer is transformed into a bandit.

USA - Conservation As A National Agenda

The United States of America is perhaps the only country where anything in the nature of an accurate estimate of the damage done by erosion has been made. Theodore Roosevelt first warned the country as to its national importance. Then came the Great War with its high prices, which encouraged the wasteful exploitation

of soil fertility on an unprecedented scale. A period of financial depression, a series of droughts and dust-storms, emphasized the urgency of the salvage of agriculture.

During Franklin Roosevelt's Presidency, soil conservation has become a political and social problem of the first importance. In 1937 the condition and needs of the agricultural land of the U.S.A. were appraised. No less than 253,000,000 acres, or 61 per cent. of the total area under crops, had either been completely or partly destroyed or had lost most of its fertility. Only 161,000,000 acres, or 39 percent of the cultivated area, could be safely farmed by present methods.

In less than a century the United States has therefore lost nearly three-fifths of its agricultural capital. If the whole of the potential resources of the country could be utilized and the best possible practices introduced everywhere, about 447,466,000 acres could be brought into use—an area somewhat greater than the present crop land area of 415,334,931 acres. The position therefore is not hopeless. It will, however, be very difficult, very expensive, and very time consuming to restore the vast areas of eroded land even if money is no object and large amounts of manure are used and green-manure crops are ploughed under.

The root of this soil erosion trouble in the United States is misuse of the land. The causes of this misuse include lack of individual knowledge of soil fertility on the part of the pioneers and their descendants; the traditional attitude which regarded the land as a source of profit; defects in farming systems, in tenancy, and finance—most mortgages contain no provisions for the maintenance of fertility; instability of agricultural production (as carried out by millions of individuals), prices and income in contrast to industrial production carried on by a few large corporations.

The need for maintaining a correct relation between industrial and agricultural production so that both can develop in full swing on the basis of abundance has only recently been understood. The country was so vast, its agricultural resources were so immense, that

the profit seekers could operate undisturbed until soil fertility—the country's capital—began to vanish at an alarming rate.

The present position, although disquieting, is not impossible. The resources of the Government are being called up to put the land in order. The magnitude of the effort, the mobilization of all available knowledge, the practical steps that are being taken to save what is left of the soil of the country and to help Nature to repair the damage already done are graphically set out in Soils and Men, the Year Book of the United States Department of Agriculture of 1938. This is perhaps the best local account of soil erosion which has yet appeared.

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36.

Death of Soil

Is Death of Civilization

Bad soil is bad for global health, and the evidence is mounting that the world' soil is in trouble. We're dead without good soil. Soil holds minerals and organic compounds critical to life. Without good soil we have got nothing.

When farm productivity declined, usually as a result of soil mismanagement, civilizations also declined - and occasionally vanished entirely.

Of the three requisites for a thriving civilization: fertile soil, a dependable water supply and relatively level land with reasonable rainfall which would not cause erosion, it is likely that the third factor was most important, and evidence is mounting that soil degradation has toppled civilizations as surely as military conquest. In countries bordering the Mediterranean, deforestation of slopes and the erosion that followed has created man-made deserts of once productive land. Ancient Romans survived on imported produce from North African regions that are desert today.

A recent study of the collapse in Guatemala around 900 AD of the 1700 year-old Mayan civilization suggests that it fell apart for similar reasons. Researchers have found evidence that population growth among the Mayans was followed by cutting trees on mountainsides to expand areas for farming. The soil erosion that

resulted from growing crops on steeper and steeper slopes lowered soil productivity - both in the hills and in the valleys - to a point where the populations could no longer survive in that area. Today only empty ruins remain.

The same process of soil degradation which destroyed civilizations in the past are still at work today.

Firstly, billions of tons of soil are being physically lost each year through accelerated erosion from the action of water and wind and by undesirable changes in soil structure.

Secondly, many soils are being degraded by increases in their salt content, by waterlogging, or by pollution through the indiscriminate application of chemical and industrial wastes.

Thirdly, many soils are losing the minerals and organic matter that make them fertile, and in most cases, these materials are not being replaced nearly as fast as they are being depleted.

Finally, millions of hectares of good farmland are being lost each year to nonfarm purposes; they are being flooded for reservoirs or paved over for highways, airports, and parking lots. The result of all this mismanagement will be less productive agricultural land at a time when meat consumption is growing and expectations are rising among people everywhere for a better life.

Source:

Soil erosion: its causes and cures, FAO Corporate Document Repository, Natural Resources Management and Environment Department

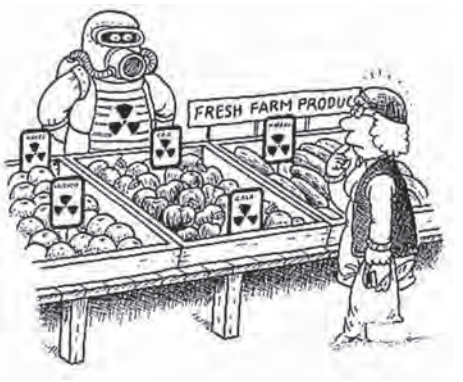
Soil Replenishment And Survival of Civilization

The history of preceding civilizations and cultures indicate the imbalances that have developed when minerals have been permanently transferred from the soil. There are only a few localities in the world where great civilizations have continued to exist through long periods and these have very distinct characteristics.

It required only a few centuries, and in some profligated systems a few decades to produce so serious a mineral depletion of the soil

that progressive plant and animal deterioration resulted. In such instances, regular and adequate replenishment was not taking place.

In nature's program, minerals are loaned temporarily to the plants and animals and their return to the soil is essential. In the case of a forest system, this replenishment is made by its plant and animal life automatically. But in case of agriculture, we have to make a conscious effort to do it. A few intelligent civilizations have done it but the balance of the cultures have largely failed at this point.



Another procedure for the replenishing of the depleted soils is by the annual overflow of great river systems which float enrichment from the highlands to the lower plains. This is illustrated by the history of the rivers like the Ganges or the Nile which have carried their generous blanket of fertilizing humus and rich soil over their long course and thus made it possible for the plains to sustain a very dense population. Where human beings have deforested vast mountainsides at the sources of these great waterways, the whole situation has reversed.

For example in China, its two great rivers, the Yangtze and the Yellow River have their source in the isolated vastness of the Himalayas in Tibet and through the centuries have provided the replenishment needed for supporting the vast population of the plains. Because of this natural replenishment, the Chinese have been exceedingly efficient in returning to the soil the minerals borrowed by the plant and animal life. Their efficiency as agriculturists has exceeded that of the residents of many other parts of the world.

But this is no longer so. Under the pressure of industrial progress, more and more of the highlands have been denuded. The forests

have been ruthlessly cut down. Vast areas that nature had taken millenniums to forest have been denuded and the soil has been washed away in a few decades. These mountainsides have become a great menace instead of a great storehouse of plant food material for the plains.

The heavy rains now find little impediment and rush madly toward the plains, carrying with them not the rich vegetable matter of the previous era, but clay and rocks. This material is not good. Instead of replenishing the soil, it covers the plains with a layer of silt many feet deep, making it impossible to utilize the fertile soil underneath.

We have only to look over the departed civilizations of historic times to see the wreckage and devastation caused by these processes. The rise and fall in succession of such cultures as those of Greece, Rome, North Africa, Spain, and many districts of Europe, have followed the pattern which we are now pursuing with great pride, under the illusion of progress.

The complacency with which the mass of the people as well as the politicians view this trend is not unlike the drifting of a merry party in the rapids over a great water fall. There seems to be no sense of impending doom.

It is apparent that the present and past one or two generations have taken more than their share of the minerals and have done so without duly returning them back. Thus they have handicapped, to a serious extent, the succeeding generations. It is not easy to replenish the minerals in the soil and it practically takes many centuries to accumulate another layer of topsoil.

This constitutes one of the serious dilemmas. A program that does not include maintaining this balance between population and soil productivity must inevitably lead to disastrous degeneration. Over-population means strife and wars.

The history of many civilizations has recorded a progressive rise while civilizations were using the accumulated nutrition in the topsoil, and a progressive decline when these civilizations were

destroying these essential sources of life. Their cycle of rise and fall is strikingly duplicated in our present industrial culture.

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Section - VI

Cow Dung

The Life And Soul Of Soil

Vital Role Of Cow Manure
In Soil Preservation

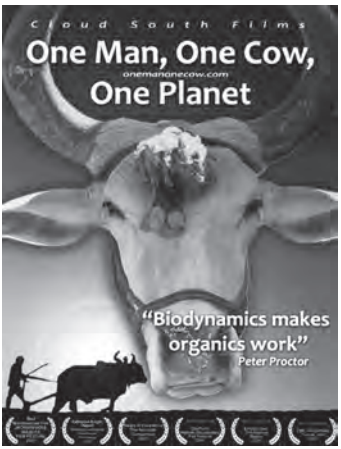
37.

A Lone Crusader With A Bucket of Cow Dung

On A Mission To Save India's Soil

Can one man with a bucket of cow dung be a recipe to save the planet? No claim could be more preposterous and more insane. That is until you watch the international awards winning film, One Man One Cow One Planet!

This is the story of a New Zealander spearheading a silent revolution in some of the world's most destitute areas, all alone with a bucket of cow dung. This film is being claimed to be a blueprint for a post-industrial future. It takes you into the heart of the world's most important renaissance.



Hero of the film, Peter Proctar is an eighty year old gardener and soil expert from New Zealand. He comes with a vast experience of sixty years in his field.

His favourite animal is the cow because of all the dung she provides. Dung is something that Proctor prizes more highly than gold, jewels, fossil fuels, or many other natural resources. His favourite invertebrate is the earthworm, which he describes as "the unpaid servant of soil health."

In the film, his farm operates on human scale, and is self sustaining, ethical and biologically diverse. It is a blue print for future when fossil fuels will be scarce. World's most valuable commodity will be the knowledge of how to farm and the wisdom of how to grow food that is more than just stuff to fill our stomachs. Indeed what he is presenting may be the last chance this planet has.

His proposal assumes significance as our existence on this planet gets precarious and as modern industrial agriculture destroys the earth.

Desertification, water scarcity, toxic cocktails of agricultural chemicals are pervading our food chains as ocean ecosystems collapse and soil erosion and massive loss of soil fertility take place all over the world. Our ecosystems ore overwhelmed. Humanity's increasing demands are exceeding the Earth's carrying capacity. Modern agriculture causes topsoil to be eroded at 3 million tons per hour. (that's 26 billion tons a year)

Human mass is replacing biomass and other species. The carrying capacity of the earth is almost spent. To maintain our comfort zone lifestyles we will soon need five earths to sustain us in the style to which we have become accustomed.

Mainstay of any civilization is its agriculture. It thrives and survives on agriculture, because food is all that matters, first and foremost. Two other essential ingredients, water and air are of course free. Industries are artificial and they sap the vitality of human beings and nature. They deplete all resources, human, environmental and natural. Industries are a short run drama and a drama doesn't last very long. Next few decades will see the sad ending of this drama when the curtain of realities falls. Agriculture is real life. Drama is for few hours and real life is forever.

Modern industrial agriculture is a form of molesting earth. Humanity is set to pay a big price for this callousness, for this crime. Lesser and lesser number of people today are having an interest in agriculture. Unscrupulous profit crazy corporations are taking over

small farms. These corporations have only one relationship with Earth - that of exploitation & profiteering. All this can not last forever. We are taking food for granted, we are taking God's nature for granted. Its not going to work. Something has to change and something will change, whether we like it or not.

Agriculture is still the occupation of almost 50% of the world's population, but the numbers vary from less than 3% in industrialized countries to over 60% in Third World countries.

What if the world were an apple? One quarter of the apple is land and the rest is water. Cut the one quarter of apple, that is land, into half and put aside that half which is deserts and mountains. Peel of what is left and that represents the topsoil that must feed the whole world. This analogy illustrates how important it is to get the best out of the available soil to provide abundant and nutritious food for everyone on the planet.

But modern agriculture couldn't care less for this precious resource. Modern agriculture is at war. It is at war with the mother Earth, with the environment. The weapons used in this war are massive agricultural machines, chemical fertilizers, herbicides, fungicides, pesticides and now genetic manipulation of the crops.

At the end of World War II, military industrial complex needed new markets for its surplus chemicals. It gave birth to Agriculture Industrial Complex. Decades of our addiction to these chemicals have led to toxic oceans, toxic water, toxic air and toxic food. From chemical deserts of factor farms to our inner life, our world as a place of nature is unrecognizable.

Most of us are far removed from the fields where our food is grown. Separating us from our food, our primary source of life, is a vast globalized distribution system, controlled my multinational corporations.

Fight against corporate control of our food is the fight for food sovereignty. When corporations dictate what farmers must grow, they are controlling what all of us must eat. The outcome of battle for agricultural control may dictate the future of the Earth.

India - A Case Study

Peter has been working with crisis-struck farmers in India for the past fifteen years and providing a strong grassroots alternative to industrialised conventional agriculture, which is failing on all counts.

India was one of the richest countries in the world, not because of its gold, diamonds or rubies, but because of its bio-mass. In India they could grow anything because of wonderful temperature, wonderful climate, the moisture and the warmth. That was the secret of India's legendary wealth.

India has been an agro-based economy since time immemorial. Cow has been an integral part (backbone) of its agriculture. But during industrial development and Green revolution, they switched over to chemical based and machine based farming, replacing age old methods involving cow dung, cow urine, and bull power.

Today chemical-based farming (Green Revolution) has rewarded India with degradation of soil, low yields of crops, emergence of new pests and diseases and percolation of toxic chemicals into the food chain.

This has resulted in more than 1.85 lakh farmers committing suicide all over India in the last 15 years. For millennia, organic cow based farming was practiced in India without any marked decline in soil fertility.

Green revolution was supposed to alleviate India's hunger. Viewed holistically, green revolution was a failure. Chemical agriculture

destroyed India's natural abundance, farming communities and soil. High yielding plant varieties turned out to use far more water, growing significantly less crop per drop. Today in much of India, rivers have long since dried up. The only water is hundreds of meters down.

Just the thirty or forty years of chemical usage has destroyed the soil which was working flawlessly for thousands of years. International Water Management Institute describes India's green revolution as 'living on borrowed water, and borrowed time'.

As an alternative to this destruction, the method Peter Proctar is proposing is called biodynamic farming. Cow which is venerated in India, is central to this biodynamic farming. With her 4 stomach, she is a unique animal of digestion. Cow dung forms the basis of many biodynamic preparations. Cow Pat Pit (CPP) is one way of processing cow dung. Proctors call is 'Muck And Magic' because the recipe contains mystical preparations.

A farmer who acquired a field six years ago was asked - how was the land when you started? He replied, "It was quite hard, like a rock." Why? "Because they were using chemicals at that time." How is it now? "In last six years, I have put compost and green manure, and it has become like cotton and even further it has become like butter. Its so smooth and easy to cultivate." Why are so many birds here while you are cultivating? "There is such a population of earth worms now, and as I cultivate they eat the earthworms and insects as they come out," came the reply. Healthy soil makes healthy plants, healthy animals and healthy people.

Cow Based Biodynamic Agriculture

Biodynamic agriculture is an advanced form of organic agriculture with an emphasis on food quality and soil health ; and as such, uses no synthetic fertilizers or pesticides. 'Biodynamic' originates from two Greek words, bios meaning life, and dynamos meaning energy. The pioneer of biodynamic agriculture was Rudolf Steiner (1861-1925) an Austrian scientist, philosopher, and educator. He identified the deleterious effects on the soil and the deterioration of the health and quality of crops and livestock that farmers experienced following

the introduction of chemical fertilizers at the turn of the twentieth century. In a series of eight lectures known as the "Agricultural Course" made in 1924 Steiner taught the fundamental ecological principle that the farm is a living organism, an individual self-contained entity within a whole harmonious system. Bio-dynamics is a complete holistic outlook on agriculture. Though the Steiner theory of biodynamics might be a bit esoteric on reading, when it is put into practice, it becomes eminently practical.

Bio-dynamic agriculture is the oldest organic farming movement practiced in over 40 countries in the world. It includes the normal organic farming practices, such as the use of compost, green manures, and crop rotation. In addition, Bio-dynamic agriculture uses a series of Preparations numbered from 500 to 508 which are based on various mineral, plant, and animal substances. These enhance all the bacterial, fungal and mineral processes that are found in the organic farming system. Placing great importance on the auspicious positions of the moon, sun and planets, a Planting Calendar is used for applying the biodynamic preparations, sowing seeds, planting plants, applying liquid manures, spraying fruit trees and crops, and other farming activities. Experience has shown that use of the Bio-dynamic techniques can make all organic farming processes work more quickly and better.

A biodynamic farm is characterized by self-sufficiency and biological diversity where crops and livestock are integrated, nutrients are recycled, and the health of the soil, the crops and animals, and the farmer too, are maintained holistically. Consideration of the farm as an ecosystem feeds into holistic management practices that embrace the environmental, social and economic aspects of the farm.

Its objectives differ significantly from those of conventional agriculture, or agribusiness, which maximizes profit with mechanical and technological inputs for unlimited exploitation of the Earth's resources. The biodynamic model feeds family and farm workers first, and then trade surpluses to the local community. One main difference between organic and biodynamic farms is that organic farms often exclude animals for ethical reasons and monocrop production is common.

Movements like this may be the last chance this planet has for a healthy, secure, and ecologically efficient food supply.

An Emergent Agricultural Knowledge System Against The Corporate Takeover

Biodynamic farms have broad ecological implications as a blueprint for agriculture when fossil fuels are scarce. But they have cultural implications too. Today in India, biodynamic and organic farming methods represent a revolution, one farmer at a time, against the vested interests of agribusiness disguised as science and the global dominance of corporations such as Monsanto.

The advantage of a cow based biodynamic farming for Indian farmers is that they are practising a form of non-chemical, non-toxic farming that does not require the use of any hybrid or GM seeds. Monsanto is a company that's trying to monopolise seed production and its only objective is that every farmer in the world who buys seed should buy from Monsanto. As 60 percent of India's population depends on small and marginal farming, the impact of stopping traditional methods of seed saving and swapping, and taking farmers to court for patent infringement where they are fined 1-2 million rupees, is literally killing them. Indian farmers want freedom and independence from corporate control. They don't want any Monsanto or Syngenta to tell us what seed they grow and what crop they should harvest and what food to

eat. This perspective reflects Gandhi's definition of food sovereignty or the right of all people to decide what they grow and eat free of international market forces.

Peter Proctor's book, Grasp The Nettle explains how it all works. The cow dung is used to create compost and it has to be prepared in a particular way. It involves CPP or Cow Pat Pits where the cow dung is layered in pits. One preparation involves the dung being put into cow horns and then being buried. It is left in these pits right through winter after which the crumbly textured mix it turns into is mixed with water and sprayed on the crops. This preparation enables the plant to hold on the moisture for longer and helps the roots go deeper. The experiments are a total success – farms that have adopted this method have healthier and juicier crops. Little wonder that Peter Proctor is almost venerated by the rural Indian farmer, many of whom have wiped out their debts and shed the yoke of corporate control thanks to following his 'back to Nature' philosophy. When they hear he's visiting, they come from miles around, sitting around him with their ubiquitous cell phones, waiting to hear the words of wisdom that fall from his mouth about the state of the soil. After all, it's because of him that thousands of Indian farmers have stopped using chemical fertilizers and pesticides and have adopted biodynamics as a way of life.

Maybe it was easier in India than anywhere else in the world. After all, the cow has always been worshipped and it was easy enough to make them see why this way was so much better. Cow dung has traditionally had a number of uses in India – made into cakes and burnt as fuel, mixed with water and applied on floors to prevent insects from coming into the home and to manufacture biogas. And maybe the typical small holding Indian farmer was in tune with his land – and his cow of course – to realize that the so called green revolution, ushered in by the global pesticide manufacturers, only resulted in polluting the soil, poisoning it as well as the ground water. Unlike many other places in the world, the harsh effects of chemical farming were much more visible here

much sooner. With over half the population in India depending on agriculture, this was devastating!

Maybe that's why Peter Proctor can be seen working among the rural farmers of India - maybe it was so much easier to convince people who lived in close communion with the land rather than farmers in more westernized societies where it takes much longer for the ill effects of chemical farming to be felt. Maybe when the holdings are small and so much depends on it, there's a sensitivity to the soil and its needs – and an awareness of when things are good and in harmony with the rest of nature.

India's Organic Farms Work At Village Level

During the past fifteen years, Peter Proctor has visited India twenty five times to teach biodynamic farming methods to as many farmers as possible. Despite his eighty years, he visits ten villages a day. Proctor's involvement is part of a major campaign to promote and encourage alternative forms of agriculture that use no synthetic inputs in response to an epidemic of farmer suicides, most of whom were farming GM crops. This initiative has encouraged 4 million hectares under organic farming methods and 1000 officially supported training schemes for biodynamic and organic farms in the Maharastra region, a suicide hotspot. These farms work at village level and each village has formed an organic federation accredited at district level where farmers participate to solve their own problems. By building up their knowledge base, farmers gain independence from agribusinesses through reducing external inputs. By using biological practices such as green manures, cover cropping, companion planting, and natural insecticides, money is saved that would have been spent on costly pesticides and fertilizers, and is put back into their own communities to improve the quality of life of everyone. This great change in rural prosperity has brought whole

communities back together again and enabled the integration of health education in local settings.

The good news about the benefits of this cow based farming has spread quickly and there are now in excess of 2,00,000 compost piles throughout India that recycles cow dung, paddy straw and almost anything else nature provides. Recycling local and freely available resources such as leaves and dung from the ubiquitous and revered cows provides an appropriate alternative technological strategy for Indian farmers and doesn't cost lives.

Alternatives To The "Green Revolution"

How to Save the World is an award winning independent film that documents the progress of Peter Proctor and his cow based biodynamic farming movement in India. Writer and director Barbara Burstyn treats us to visions of verdant biodynamic farms where colorfully dressed young men and women prepare the field preparations and spray them in spiral motions from large copper bowls onto the soil. The old ploughman driving two golden cows tells his story of how the soil has become soft and almost butter-like and alive with worms under biodynamic systems. Elsewhere, we see vast areas of land where the soil is so saturated with layer upon layer of chemicals that it has become great lumps of dry, dusty boulders where no life exists. Organic farmer Jaspal Singh explains that this is the result of the "Green Revolution", that has not only been a killer of farmers, but has made the soil unproductive, waterlogged, pest infested, depleted of nutrients, and has dried up rivers. Singh says that until he learned about chemical free organic and biodynamic farming systems that uses fifty percent less water, he had no alternative to the chemical and water intensive practices of the Green Revolution.

Despite the negative effects of chemicals on the soil, the use of pesticides is increasing and claims the lives of at least 2,00,000 people per year in India by direct poisoning.

In India, seed dealers get huge commission from chemical companies and Indian farmers are forced to take hybrid seeds and pesticides as part of credit packages from salesmen in order to

continue to farm. Shantytowns of farmers evicted from their lands because of failed harvests and unpaid debts have sprung up by the rows of pesticide sellers set up in small roadside huts with shelves filled with packets of GM seeds and cans of pesticides. These seeds cost farmers four hundred percent more and yield thirty percent less. A 2006 report shows that 60 percent of farmers using GM seed could not cover their investment, let alone feed their families.

The film, How to Save the World captures the rhythmical movement and vitality of India, but cannot resist a cynical take on the corporate model that builds a market by forcing once independent farmers into debt and dependence on international aid for the very same grains and legumes they once grew successfully. It puts the blame for dependency and for world hunger fairly and squarely on the shoulders of industrial agriculture, genetic engineering, military dominance and trade liberalization, and not on food scarcity. The failure of the globalised free market is starkly symbolized by miles of empty toll roads, built as an infrastructure for corporate agriculture that many farmers in India cannot afford, or do not want.

How to Save The World leaves us in no doubt that one would be fortunate to find oneself connected to an idyllic rural biodynamic farm where pay and conditions for workers and their families are fair, food is of the highest quality and plentiful, the local economy thrives, the farm shop is a sell out, and the farmer and the local community is happy and content. And there is no reason why million more small to medium sized farming communities everywhere could not enjoy the same good life.

What Peter Proctor is doing however, is starting a revolution – quietly and effectively at the grassroots level of agricultural India. Why did this man come all the way from New Zealand braving the heat and dust of rural India to start a movement that would take on the might of multinationals and their juggernaut on its way to control everything we eat and drink? Why would a man who is partially deaf, with one glass eye, an opera buff, who doesn't particularly like spicy Indian curry come halfway across the world

to try and save debt-ridden Indian farmers from the clutches of corporations like Monsanto?

Because he cares. Yes, Peter Proctor cares – and this caring goes beyond the farmers and their plight. He cares about the planet and what we as humans are doing to denigrate it. He cares enough to say, 'Enough!' and to do his bit to work in tandem with Nature, not against it. He cares enough to want to try and bring back the beauty of balance that Nature should ideally have. To repair the delicate web of interdependence that all creatures in the world should be connected with.

38.

Vital Role Of Cattle Manure

In Maintaining Soil's Organic Matter

By William A. Albrecht, PhD

The use of "fossil" fuels in their various forms, like coal, kerosene, gasoline, and other volatile, readily combustible materials for agricultural power, to replace that of horses and mules, has brought about the highly exploitative attacks on the natural reserve organic matter of our surface soils.

This has resulted for two reasons: (a) more power and speed are applied to the tilling of the soil more deeply and vigorously to hasten the combustion of the reserves of microbial energy materials; (b) less organic matter is returned in the animal feed residues as manure, modified and improved as nutrition for the soil microbes and plants by the addition of the chemically more complex and varied waste products of the animal's physiology.

Striking Results . . . Cattle manure (six tons per acre annually — right) demonstrated its effects (July, 1958) in the upkeep of soil productivity under corn continuously (69th successive crop) in contrast to that of the soil under similar cropping but no manure (left). The same noble hybrid seed on both plots didn't overcome the difference in the soils due to manure and no manure.

Reasons

The first of these reasons has been widely recognized as an unavoidable result of the high labor costs demanding such speed to raise the output per man.

The second reason has been generally disregarded. Manure handling has always been considered a distasteful sanitary chore incidental to keeping animals housed and penned, more than it has been appreciated as an essential, biochemical contribution to the nutritional quality of feeds and foods grown on manured soil. Also, it simultaneously does much to maintain the organic matter in its fertilizing services.

Chemical studies were made of the soils after 67 years of (a) no cattle manure on one set of plots, and (b) six tons per acre annually on another. Each set in such contrasting pairs had been under cropping to (a) wheat, (b) corn, (c) timothy annually, and also to (d) a four-year rotation of corn, oats, wheat, and clover, and (e) a six-year rotation of corn, oats, wheat, clover and timothy. From these data, it is clearly evident how much the use of barnyard manure (cow dung) has contributed to help in the upkeep of the organic matter supply in those soils. (See the table).

Soil Composition--Due to Barnyard Manure after 67 Years. Sanborn Field, Columbia, Missouri

Crop	Treatment	Organic Matter %	Phosphoric Acid, lbs/A	Essential M.E. Ca	Cations Exchangeable Mg	Cations Exchangeable K	Cation Exchange Capacity M.E.	Hydrogen M.E.
Wheat	Manure	2.4	189	2140	306	348	16	8.5
Wheat	None	2.1	77	1900	360	312	16	9.5
Corn	Manure	2.2	202	3350	565	414	17	6.0
Corn	None	1.4	62	2600	462	239	15	8.0
Timothy	Manure	3.0	201	2650	216	273	15	4.9
Timothy	None	2.3	15	2100	140	144	15	4.8
4-year Rotation	Manure	2.7	151	3850	245	307	18	4.8
4-year Rotation	None	2.0	38	3230	245	307	18	4.8
6-year Rotation	Manure	2.5	94	2600	210	233	16	4.5
6-year Rotation	None	2.0	22	2866	108	113	16	4.6

Results

Under cropping to wheat continuously, the manured plot of soil had 2.4 percent of organic matter, when the unmanured one had only 2.1 percent. The former was three parts richer over 21 parts, or higher by one-seventh. Under corn continuously, the manure plot was higher in organic matter after the 67 years by four-sevenths. Under timothy sod continuously, the increase figure was nearly one-third; under the four year rotation, it was over one-third; and in the six-year rotation, one-fourth, or next to the lowest, which was the soil under wheat. These were the effects from using manure when in all of these cases the entire crops had been removed and no crop residues were returned.

Help From Cattle Manure

As additional significance, there is the help from barnyard manure in the maintenance of the inorganic part of the soil fertility. This was shown by the ash analysis of the soil for phosphate (phosphoric acid, P2O5) and for some of the cationic essential elements, namely: calcium, Ca; magnesium, Mg; and potassium, K.

It is also significant to note the help from manure in keeping up the soil's exchange--absorption capacity (cation exchange capacity), in which the organic matter is more active than the clay. Also the lowered soil acidity resulting from the use of manure, as measured

by the amount of exchangeable hydrogen, in the soil after 67 years, deserves attention as a modified soil condition not commonly appreciated in connection with this soil treatment.

Contrasting values in each of the above cases of the elements cited for manure and no manure (Table) show clearly that manure has fertility values we do not commonly emphasize.

Demonstration

After nearly three score and ten years of manuring, this treatment demonstrates that, in the matter of soil maintenance, cattle manure has values for:

(a) upkeep of the supply of reserve organic matter;

(b) holding up the soil's content of phosphorus even when manure is relatively low as a fertilizer for this essential element;

(c) preserving the supply of active potassium;

(d) maintaining the exchangeable magnesium;

(e) preserving the supply of active calcium; and

(f) helping to hold down the excessive concentration of acidity as hydrogen.

Manuring the soil has been doing these things for years under merely the belief in it as a good practice, and long before science gave us these few tabulations of what we can prove in favor of cattle manure. In the organic matter of the soil as part of the nutrition of microbes, plants, animals and man there is still much in the realm of good practice and much remains yet for science to prove and to explain.

Respect For Nature

The facts that have been outlined will be observed in nature by those who do not have preconceived ideas about plant growth. Unfortunately the professional agriculturalist often views the

effects of soils on the plant's growth with a distant outlook, as if the only problems were those of industrial manipulation of dead materials, with emphasis on the various technologies for economic advantages only.

People who approach agricultural research in this way have lost sight of agriculture as a biological demonstration by the forces of nature, *where man is more spectator than manager in complete control of soil and produce.*

Such unrealistic views of agriculture have led to expressions and views by high government officials that soil is but a chemical and physical agent for the production of larger quantities of crops. They seem unaware that the soil of our planet is a complex material developed through many centuries, having the power of creation, not only for plants, but for everything that lives, moves and has its being upon the earth.

(William A. Albrecht, Phd, 1888–1974, was the Chairman of Department of Soils, College of Agriculture, University of Missouri, Columbia.)

39.

Organic Matter In Soil

Best Defense Against Erosion And Water Shortages

By Donald P. Hopkins

Organic matter in soil can absorb and store much more water than can inorganic fractions. It acts like a sponge, taking up water and releasing it as required by plants. It also helps bind soil particles into larger aggregates, or crumbs. Soils with this kind of structure are very resistant to erosion. Conversely, nearly all soils containing little or no organic matter are very susceptible to erosion.

Besides absorbing water readily, a good cropland soil should be able to dry out or warm up quickly when the rain is over. It should hold enough moisture to supply the needs of a crop between rains,

"A governmental policy which results in impoverishing the natural fertility of land, no matter by what particular name it is called must have an end. It is only a question of time when this truly spendthrift course, this abuse of the goodness of Providence, shall meet its inevitable punishment.

Down to this day, great cities have ever been the worst desolators of the earth. It is for this that they have been so frequently buried many feet beneath the rubbish of their idols of brick, stone, and mortar, to be exhumed in after ages. . . . Their inhabitants violated the laws of nature which govern the health of man and secure the enduring productiveness of the soil.

yet permit water to pass through the soil. A good soil will not stay too wet or too dry.

There are other, less obvious relationships between soil erosion and crop selection and management. Many soils can be planted with maize without much erosion risk if the maize crop is rotated with legumes and small grains. If maize is planted year after year, however, soil losses begin to mount.

40.

Earthworm - Our True Friend

Cattle Manure Is Earthworm Friendly And Chemical Fertilizers Destroy Them

Donald P. Hopkins (Chemicals, Humus And The Soil)

When we come to the larger soil organisms, and in particular to the earthworm, the humus school stands in a stronger position. For the earthworm's contribution to soil fertility has been sadly neglected by modern soil science. Even in the United States where official research facilities in agriculture are so liberally supported, even there most of the modern work upon the earthworm has been left in private hands.

The scientific estimation of the earthworm's contribution begins with Charles Darwin. Over a number of years he observed worms' habits and the many kinds of soil changes they brought about, and in 1881 he published a monograph, The Formation of Vegetable Mould Through the Action of Worms with Observations on Their Habits.

`This exhaustive study was no ordinary record of a naturalist's investigation, otherwise there might be more excuse for the scanty attention paid to it by contemporary and later science. Darwin was not content to present a 'purist' view of the worm—he went much beyond this and stressed the important consequences of worms'

habits to the soil. But what should have been a classic in scientific literature caused practically no stir at all. Darwin's fame was to rest upon apes, not worms.

In 1945, however, and in no small measure due to the activity of the modern humus school, this book was republished under the neater title, Darwin on Humus and the Earthworm (Faber and Faber), with a preface by Sir Albert Howard. Not unnaturally Sir Albert tied up Darwin's neglected points with the humus school thesis. But before we inquire into this enrolment of Darwin as a member of the humus school—or should it be as a distinguished past-president?—it is best to see what Darwin himself said.

The charge that chemical fertilizers are a prime cause of unhealthy growth is shown by the following quotations:

'Diseases are on the increase. With the spread of artificials and the exhaustion of the original supplies of humus carried by every fertile soil, there has been a corresponding increase in the diseases of crops and animals which feed upon them.'

~Sir Albert Howard, An Agricultural Testament.

'My canes (raspberry) have not had any chemical fertilizers, and in consequence have not required spraying. In this, as in other cases, no chemicals means no sprays.'

~F. C. King, article in The Market Grower, 18.3.44.

'The accelerated growth induced by chemical fertilizers has the effect, among others, of speeding up the rate at which humus is exhausted. As this depletion of humus proceeded, troubles began. Parasites and diseases appeared in the crops, and epidemics became rife among our livestock, so that poison sprays and sera had to be introduced to control these conditions.'

~E. B. Balfour, The Living Soil.

'Now sulphate of ammonia and many other artificial manures are likely to kill the earthworm and bacterial life of the soil, and so one gets ill-nourished plants which are liable to fatal attack by disease and insect pests. Disease, fungus, and insect pests are always with us, but they chiefly affect the unhealthy plant.'

Apart from a large number of brilliant deductions about the way worms live, Darwin proved that they eat raw and half-decayed organic matter and also pass through their bodies considerable quantities of earth. In this intermingling process they produce a rich vegetable mould or well-humified soil, and this is constantly being added to the upper surface of soils.

To quote the original monograph: 'Worms have played a more important part in the history of the world than most persons would at first suppose. In almost all humid countries they are extraordinarily numerous, and for their size possess great muscular power. In many parts of England a weight of more than ten tons of dry earth annually passes through their bodies and is brought to the surface of each acre of land; so that the whole superficial bed of vegetable mould passes through their bodies in the course of every few years. . . .'

And again: 'Worms prepare the ground in an excellent manner for the growth of fibrous-rooted plants and for seedlings of all kinds. They periodically expose the mould to the air, and sift it so that no stones larger than they can swallow are left in it. They mingle the whole together, like a gardener who prepares fine soil for his choicest plants.'

'In this state it is well fitted to retain moisture and to absorb all soluble substances, as well as for the process of nitrification. . . .'

As the figure of ten tons per year per acre may seem surprising, it might be as well to summarize the evidence upon which Darwin based this estimate. He was led to believe that the weight of soil normally brought to the surface by worms was fairly high from studying the rate at which large objects such as big stones or even old ruins were gradually buried in the land. He himself and one or two interested friends collected and weighed all the worm castings over timed periods on measured areas of land, on very small plots of about one square yard or so. If the areas were indeed rather tiny,

on the other hand the time period was long; but in any case the run of various results was reasonably consistent.

Darwin was able to check the reliability of these figures by approaching the same problem in a different way.

An American measurement, quoted by Sir Albert Howard, shows that the soil of the castings is very much richer than the corresponding soil.

The point that Darwin made verbally in 1881 is thus well and truly confirmed by these 1942 figures from Connecticut Experiment Station.

The Cattle Compost Factory

The compost factory at Indore adjoins the cattle shed. This latter has been constructed for forty oxen and is provided with a cubicle, in which a supply of powdered urine earth can conveniently be stored. The cattle stand on earth. A paved floor is undesirable as the animals rest better, are more comfortable and are warmer on an earthen floor. The earth on which the cattle stand absorbs the urine, and is replaced by new earth to a depth of six inches every three or four months. The compost factory itself is a very simple arrangement. It consists of thirty-three pits, each 30 ft. by 14 ft. and 2 ft. deep with sloping sides, arranged in three rows with sufficient space between the lines of pits for the easy passage of loaded carts. The pits themselves are in pairs, with a space 12 ft. wide between each pair. This arrangement enables carts to be brought up to any particular pit. Ample access from the compost factory to the main roads is also necessary, so that during the carting of the compost to the fields, loaded and empty carts can easily pass one another, and also leave room for the standing carts which are being filled.

Manurial Value Of Indore Compost

One-cart load of Indore compost is equivalent, as regards nitrogen content, to two cart-loads of ordinary farmyard manure. Properly made compost has another great advantage over ordinary manure, namely its fine powdery character which enables it to be uniformly incorporated with the soil and to be rapidly converted into food materials for the crop. Taking everything into consideration, Indore compost has about three times the value of ordinary manure. ~ *Sir Albert Howard*

There may have been other similar measurements in the interim but, if so, little attention has been paid to them. 1881 to 1942 is a long time, and the humus school can well claim in this matter that 'official' research has largely ignored a known biological factor in soil fertility - earthworms.

With this point behind them the humus school has launched a strong attack at chemical fertilizers on the grounds that these materials discourage earthworms, drive them away and thus greatly diminish their powerful contributions. Where chemical fertilizers are used the earthworm populations are low or nil; additional supplies of chemical NPK are then needed to make up for the supplies from the soil's store that would otherwise have been made available by the worms.

41.

The Importance Of Farmyard Dung

In The Beginning Days, Even Fertilizer Companies Admitted It

Donald P. Hopkins (Chemicals Humus, And The Soil)

It is often said that those who have chemicals to sell have harnessed science to their own interests rather than to the interests of the soil.

That is to say, they have paid chemists to concentrate upon the kinds of research that deal with the effects of chemicals whilst nobody else has been very ready or able to foot the bill for scientific inquiries in other directions. It is also often said that the advertising pressure of large chemical firms over-accentuates the favourable claims of chemicals, and this has in a long period led to an unbalanced fashion for chemicals even among scientists themselves.

I can't believe people pay for that...

A kind of fixed-idea-mentality has been built up. From my own contacts with people who directly live by the soil and its produce,

I very much doubt whether there could be any kind of humanity less susceptible either to subtle or crude advertising.

Suspicion and scepticism go hand in hand with the plough and the harvester.

Here are extracts from pre-war literature issued for sales-purposes by one of the largest chemical companies and fertilizer manufacturers in Britain.

When writing the original edition of this book, I made a survey of the sales-literature this company had issued, though it was admittedly limited to the amount that still remained intact and could be gathered together during the war period. I was anxious to check whether charges of chemical bias, and in particular the advocating of using fertilizers to the exclusion of manures, could be substantiated. I found that on the contrary the complementary use of manure and fertilizers had often been strongly advised.

> 'The most successful potato growers manure their crops with dung and complete fertilizers. Fertilizers will help to restore exhausted grasses to vigour, but cannot give their full effect unless the pasture is rested at the right time and is therefore in a fit condition to respond.'

The prosecution states that plants raised with chemicals are less robust, less able to withstand the attacks of fungi, pests, and viruses; so that epidemic ill health results. This being so, extra yields are short-term and illusory benefits, quantity and not quality, and quantity in any case that must be frequently discounted by severe loss.

The humus school have suggested why this happens, and we have already analysed some of their evidence for specific charges against chemicals in chapter eleven. But details hardly matter—a fact is still a fact whether it can be explained or not. And we should be able to decide whether the use of fertilizers has increased diseases and attacks by pests—it is the kind of thing that can be assessed reasonably well by observation and measurement; in the widest sense, indeed, by mass observation and statistics.

~ Donald P. Hopkins

'In every country where sugar beet is cultivated, it has been found both essential and profitable to manure the land well with dung and a complete fertilizer.'

'The best rule for the amateur to follow is to apply as much dung as he can get in order to improve the physical condition of his soil, and to make up for any lack of plant-food by the use of other organic and artificial fertilizers.'

'It is not possible to grow well-developed healthy plants with the aid of nitrogen exclusively, whether it be applied in the form of sulphate of ammonia or any other purely nitrogenous fertilizer . . . sulphate of ammonia should be used in conjunction with fertilizers supplying phosphates and potash. . . . Supplement your work of cultivation by conserving all the trimmings from your garden, all lawn mowings, hedge clippings, dead plants, and the like, in a compost heap.'

'Fertility depends on light and air; on methods of cultivation; on the presence in the soil of water; organic matter (humus); of bacteria; of nitrogen, phosphates, potash, calcium; and of small quantities of what are known as the minor elements. All these factors are interrelated so that all must be maintained at the right level if fertility is not to suffer.'

None of these quotations was printed in any lesser type than the type in the rest of the general statement. By way of history, here are extracts from a very old-established fertilizer manufacturers' guide for farmers issued as long ago as 1857.

'Judiciously applied, in agriculture, artificial manures meet the natural deficiency of valuable fertilizing constituents in farmyard manures, and when both kinds are used conjointly (which we always recommend when practicable) the value of dung is greatly enhanced.'

A good deal of compost has been made on tea-estates in North India, where the necessary vegetable matter is easily collected from the uncultivated land near the estates. The collection of this material has, however, in places led to bad soil erosion.

It is stated that the results are best when sufficient quantities of cattle or other animal manure are available; they are said to be less satisfactory where the animal manure has been deficient. Attempts to run tea estates on compost alone, however, proved unsatisfactory; it was necessary to provide the proper artificials where ever sufficient cattle manure was lacking.

~ Sir Albert Howard

'And it should always be borne in mind that these (artificial) manures are intended to supply any deficiency in quantity or quality of farmyard dung, and not to supersede its use.'

42.

Importance Of Humus In Soil Preservation

And Role Of Farmyard Dung In Humus creation

Humus is a word that was invented before the days of Liebig to cover up a large number of complexities that could not be simplified, and the word remains because the situation also remains. We are still very much in the dark about the precise composition of humus and exactly why it is so important.

However, evidence that comes from observing effects must not be rated lower in value than evidence that can explain the effects. To take up again the analogy of the trial for murder; if a witness is produced who saw the accused stick a knife into the victim, that evidence—provided the witness is reliable—outweighs all the circumstantial evidence that tries to show why the accused had reason to commit the murder or how he had the opportunity and so on.

Humus is the dark brown or black decomposed organic matter invariably noticeable in what are called rich soils. Farmyard manure, stable manure, vegetable waste matter, these in their fresh forms are not humus but rather the raw materials that can be turned into humus.

Its Properties

By far the simplest way to interpret humus is to list the things it can do. Its properties—from the point of view of soil fertility—can

be divided into three classes; mechanical or physical, biological, and chemical.

The physical or mechanical effects are as follows. It can bind together a light, crumbling soil; but it can also make a sticky, heavy soil more friable.

The erosion disasters in the United States, in which thousands of crop-producing acres became a desert or 'dust-bowl', are now generally admitted to have been caused by humus deficiency. The soils were originally very rich; they were farmed without attention to humus replacement—the top-soils became more and more friable, crumbled into dry dust; then, once a certain level in deterioration was reached, nothing could save the soils from being swept away by rough weather.

Humus keeps the soil particles apart and so keeps air moving through the soil. It holds water better than soil so that plants in a humus-rich soil are less affected by drought conditions.

Sir John Russell has reported that plots at Rothamsted regularly treated with farmyard manures contain 3 to 4 per cent more water than plots under similar cropping conditions but which receive non-humus containing manures. And, of course, every gardener knows how much better are his moisture-needing summer crops like beans, peas, tomatoes, marrows, etc., if rotted organic matter is trenched in underneath them.

A minor physical effect comes from its colour, for by tending to darken the soil it increases the absorption capacity of the soil for warm sun rays and thus can keep the soil temperature a little higher.

Its biological properties are vital. It increases the activities of so many organisms whose work is a favourable factor to soil fertility.

'Humus is a natural body; it is a composite entity, just as are plant, animal, and microbial substances; it is even more complex chemically, since all these materials contribute to its formation.'

~ S. A. Waksman

From the earthworm to the invisible earth bacteria, the life of the soil population is stimulated by the presence of humus. This is an important matter that we shall have to consider in much more detail later—for the moment let it be left at that.

Chemically, humus—or at any rate the manures that contain humus—will contain supplies of the elements of plant-growth. This is obvious for the manures have been produced by the 'rotting' of plant material-—whether a cow has eaten, digested, and expelled grass or mangolds or whether waste green material has been directly composted in a heap.

At this preliminary and general stage, we need not go into the question of how much of the original minerals etc. taken from the soil by the plants will still remain in the humus type manures which are later put back into the soil; but clearly the manures will have some definite value of this kind.

Also, in this plant food department of soil fertility, humus plays an indirect role; for it can increase the soil's capacity for retaining soluble (and therefore active) kinds of these plant-foods. As we shall see later, there is always a tendency for immediate fertility in soils to be lost through the soil's inability to hold all its active plant-food supply indefinitely. So that the help of humus in compensating for this adverse factor is important.

Humus Creation

How can the humus content of the soil be kept up? By the digging or ploughing in of animal manures—farmyard, stable, or sewage manures. By composting all organic wastes. By the deliberate growing of what are called 'green manure' crops, e.g. mustard, for digging in.

And by the digging in of all crop wastes left after harvesting, e.g. stubble, mangold tops, and so on. When grassland is converted to arable land, as has happened so widely in wartime, the turned-in turf provides valuable humus as it slowly rots down in the soil.

It will be noted that the application of fertilizers has not been given as a direct method of providing humus, but the application of bulky organic manures is. This is a fundamental distinction.

Larger crops mean bigger residues for ploughing-back, and also bigger root systems left in the soil to rot down into humus. The extent to which the below-ground parts of crops provide humus is much under-estimated. When a ley is ploughed in, we realize obviously enough that its green stem and foliage matter must make a big contribution to the soil's humus; but the thick mass of root systems underneath may well make an even bigger one.

Farmyard Manure Vs Fertilizer

The difference between farmyard manures and fertilizers is confused by the fact that the manures contain not only humus but also supplies of the fertility elements. In this latter sense, therefore, they overlap the function of fertilizers. We must neither exaggerate the value of this overlap, nor underestimate it.

Important questions affecting the whole argument about fertilizers are: (1) how much 'chemical' plant-food do these natural manures provide; (2) how much natural manure of all kinds is, or can be made, available; (3) how much plant-food must be added to the soil to maintain fertility at the level necessary for our requirements?

It is the chemical plant-foods with which fertilizers are more concerned. Liebig made the point that any element found by analysis in the composition of a healthy plant was ipso facto an element necessary to its proper growth. (It is not so true in a quantitative sense, for an element that is present in large quantities in a plant may not be any more important than one present only in very much

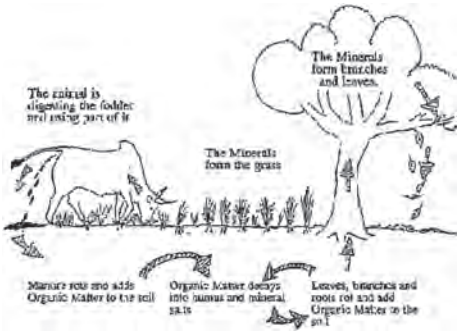
If your energy is all engaged in manufacturing tires and wheels, then who will go to the farm...So gradually farming will be reduced, and the city residents, they are satisfied if they can eat meat. And the farmer means keeping the, raising the cattle and killing them, send to the city, and they will think that "We are eating. What is the use of going to..." But these rascals have no brain that "If there is no food grain or grass, how these cattle will be...?" Actually it is happening. They are eating swiftly.

-Srila Prabhupada (Room Conversation with Dr. Theodore Kneupper — November 6, 1976, Vrndavana)

smaller quantities. The different elements have different functions. One element may function as a direct food; another may be needed only in traces in order to allow the plant to digest the first element.)

The elements found in plants generally are: carbon, nitrogen, hydrogen, oxygen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, chlorine, boron. Even this is not a complete list but it contains the main ones and some minor ones.

Now of these elements there are three important ones that the soil itself does not seem able to supply sufficiently for our cropping needs—nitrogen, phosphorus, and potassium. Each harvested crop takes away supplies of these elements that have come from the soil and, after a time, these losses reduce the soil's ability to go on feeding crops.



By sampling and analysis it is a simple matter for a chemist to measure just how much of these elements is removed, say, per acre by a crop.

Thus, a good crop of potatoes might take from the soil about 150 pounds of potash (oxide of potassium) per acre. What happens to this 150 pounds? The potatoes are eaten, digested, expelled from the human system into the sewage system. In a modern city this usually means that the sewage is treated and then conducted into a river or sea as quietly and unobtrusively as possible. That part of the potash in the discarded peelings may go on to a compost heap or be fed to pigs

'The fixation of nitrogen is vital to the progress of civilized humanity, and unless we can class it among the certainties to come, the great Caucasian race will cease to be foremost in the world, and will be squeezed out of existence by the races to whom wheaten bread is not the staff of life.'

~ Sir William Crookes, 1898.

or poultry in which case a fraction of the potash will eventually find its way back to the soil. But, in sewage disposal, most of the potash is lost completely.

Admitted, there is some sewage reclamation carried on, but it must be remembered that sewage in modern sanitation is heavily diluted with water and this means that the active plant-food—the kind that can dissolve in water-must pass into the liquid fraction of sewage. And it is this liquid fraction that is discarded in most systems—the sludges that are reclaimed at some works are composed of the solid, insoluble parts of sewage. There is, therefore, continuous loss. In less civilized countries—or perhaps it is fairer to say less industrialized countries— the sewage is disposed of by putting it directly back on to and into the soil.

In cattle farming, the nitrogen, phosphorus, and potash consumed when the cattle eat grass or fodder crops returns to the farm as manure. That is why the farmyard manures have been valued so much in traditional farming.

43.

Land Restoration

In India's Conflict Zones

India has a total of 671 districts and out of these, 82 districts are severely affected by Maoist insurgency. These insurgents practically control these vast swathes of territories and even security forces have a hard time accessing some of these areas.

Collapsed agriculture and soil erosion is responsible, in no small measure, for the rise of inurgency in these areas. The youth often have no means of livelihood other than joining the rebel ranks.

One such district in Central India's Chhattisgarh state is Kanker. Most of the land here is degraded and agriculture is in shambles.

Government Projects Facing Reistance

In 2010, the government launched an 820 crore rupee ($150 million) initiative to develop the district. This included building roads, supplying electricity and drinking water, building schools and community health centres and implementing the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), a programme designed to end rural poverty by giving 100 days' employment a year to the rural poor.

The plan faced stiff opposition from Maoist activists, who said it would only lead to displacement of local tribal people and fill up the pockets of corrupt government officials.

Kalavati Salam, a resident, recalls how Maoists disrupted a government project in 2010. "We brought in trucks full of stone chips, cement and sand to build a tar road. But when the bulldozers came, they set them afire. We had to stop the work and couldn't spend the budget allocated for the project."

A half-built archway at the village entrance, together with heaps of stone and concrete on the roadsides, back up her testimony.

Maya Kavde, head of Makdi Khuna, another village in the same district, says suspected Maoist activists recently vandalised a mobile phone tower in her village by cutting wires and pulling apart the antennas.

Four years after Kalavati Salam was elected to lead the Nangarbeda village council in Central India's Chhattisgarh state, she has finally got her first development plan rolling.

The plan, focused on reversing land degradation and boosting crop yields, benefits from a generous budget and a dedicated work force. Equally important, it has the support of the Communist Party of India (Maoist), a banned political organisation that has blocked many previous development efforts.

"Now we are taking up works like restoring village land. We are trying to change the definition of development," she adds, visibly relieved.

When we examine the facts, we must put the Northern Indian cultivator down as the most economical farmer in the world as far as the utilization of the potent element of fertility—nitrogen—goes. In this respect he is more skilful than his Canadian brother. He cannot take a heavy overdraft of nitrogen from the soil. He has only the small current account provided by the few pounds annually added by nature, yet he raises a crop of wheat on irrigated land in the United Provinces that is not far removed from the Canadian average. He does more with a little nitrogen than any farmer I ever heard of. We need not concern ourselves with soil deterioration in these provinces. The present standard of fertility can be maintained indefinitely.

~ Sir Albert Howard (The Waste Products Of Agriculture And Their Utilization As Humus)

The process includes levelling the land, clearing it of stones, and then covering it with cow dung.

"Most of the farm plots here are uneven, lifeless. We remove layers of soil from those plots that are higher, until the entire farm is at the same level," says villager Sonkumari Bai, 42. "We also remove big and small stones. Sometimes we winnow the top soil before putting it back into the land. *Finally, we till the land and cover it with dried cow dung and gypsum."*

The inhabitants of Nangarbeda, which has a population of 2,700, hope this will help improve their harvests.

"The temperature here is increasing day by day. Earlier in the summer, we would grow vegetables like cucumbers and cow beans. But now the land is so dry, we can grow nothing," says Bhagobai Pradhan, who has a three-acre farm. "This treatment has made some difference. When the rain comes, the once-tilled land will get soaked easily and the cow dung will mix with it well."

Nanak Baghel, a senior Maoist leader in Kanker, says his party fully supports the land restoration project.

"We are against the government-backed so called development projects that are just tools to systematically destroy the tribal people. But we never oppose people's right to better land, water or forest," says Baghel, an area commander.

Sukhanti Bai, head of Handitola village in another conflict-affected district, Rajnandgaon, describes how soil degradation and falling yields have pushed villagers to restore their land too.

"There are many companies here mining for iron ore and limestone. They have caused a lot of deforestation. Also security forces cut many trees to build their camps inside forests. Now, we have less rain and a lot of dust coming from the mines and damaging our fields," she explains.

"Everyone in my village is experiencing a 10 to 20 percent drop in rice yield. Last year, we held a meeting to discuss what work we must make a priority, and everyone said it should be land restoration," she adds.

The majority of the local people are landless, marginal farmers who own less than 2.5 acres of land.

According to Luc Gnacadja, executive secretary of the United Nations Convention to Combat Desertification (UNCCD), including land in development plans will help nations fight food insecurity. "Avoiding land degradation and restoring degraded land should be a centrepiece to every state's development plans," Gnacadja said in a recent interview.

For local people, the land restoration projects in these villages are not only a step towards ensuring food supplies. They also create a more secure working environment.

Ramulu Amma, a 32-year-old villager in Peda Bandirevu, says she feels safer now. We are working to improve our own fields and there are no feelings of fear or insecurity now.

(Source: Report by Stella Paul, Reuters, 7 May 2013. Stella Paul is a multimedia journalist based in Hyderabad, India.)

"We have got experience. Sometimes we find in mango season profuse mango supply. People cannot end it by eating. And sometimes there is no mango. Why? The supply is in the hand of God through His agent, the material nature, this earth. The earth can produce profusely if people are honest, God conscious. There cannot be any scarcity. Therefore it is said that kamam vavarsa parjanyah [SB 1.10.4]. God gives. Eko yo bahunam vidadhati kaman. Nityo nityanam cetanas cetananam (Katha Upanisad 2.2.13). So God, Krsna, fulfills all our desires."

-Srila Prabhupada (Srimad-Bhagavatam 1.10.4, Mayapur, June 19, 1973)

44.

Grazing

A Time-Honored Agricultural Practice

And Its Far-Reaching Benefits In Maintaining The Health And Vitality Of A Landscape.

Excessive pressure on the vegetal cover by animals can be a crucial problem, especially in developing countries where rangelands usually are much more crowded than in the developed world (FAO,1983). While livestock does not necessarily cause environmental problems, overgrazing can be a major factor in land degradation, causing half of the damage assessed in Africa and one-fourth in other developing regions.

Cases such as the damage caused by goats in the Mediterranean area and elsewhere are well known. In Africa, the increase in cattle numbers and the decline in the quality of rangelands have been significant during the recent decades (FAO,1986). These two trends are obviously incompatible in the long run, and local crises are likely in the future.

Nomadic grazing in semi-arid areas is an environmentally compatible, effective land use system developed over the centuries by pastoralists; but local collapses of such systems are being noted with increasing frequency. *Human greed, rather than human need is to be blamed for much of the damage inflicted.*

Cows - The Art Of Living In Perfect Harmony With Other Life Forms

By Morgan Kelly, February 21, 2012

In August, the Princeton researchers reported in the journal Evolutionary Ecology Research that cows paired with wildlife gained 60 percent more weight than those left to graze only with other cows.

Princeton University researchers are leading an effort to put to pasture the long-held convention of cattle ranching that wild animals compete with cows for food.

Two recently published papers — including one in the journal Science — offer the first experimental evidence that allowing cattle to graze on the same land as wild animals can result in healthier, fattier bovines by enhancing the cows' diet. The findings suggest a new approach to raising cattle that could help spare wildlife from encroaching ranches.

The reports stem from large-scale studies conducted in Kenya wherein cows shared grazing land with donkeys in one study and, for the other, grazed with a variety of wild herbivorous animals, including zebras, buffalo and elephants. The lead author on both papers was Wilfred Odadi, a postdoctoral research associate in the lab of Dan Rubenstein, the Class of 1877 Professor of Zoology and chair of Princeton's Department of Ecology and Evolutionary Biology.

In August, Rubenstein and Odadi reported in the journal Evolutionary Ecology Research that cows paired with donkeys gained 60 percent more weight than those left to graze only with other cows. The researchers proposed that the donkeys — which were chosen as tamer stand-ins for zebras and other wild horses — ate the rough upper-portion of grass that cows have difficulty digesting, leaving behind the lush lower vegetation on which cattle thrive.

In September, Odadi and his co-authors on the Science paper reported that other grazers, especially zebras, did remove the dead-stem grass layer and that cattle indeed seemed to benefit from sharing land with wild animals. Cows in mixed grazing pastures took in a more nutritious diet and experienced greater daily weight gain. — but this effect was limited to the wet season.

Nonetheless, the Princeton studies help counter an enduring perception that wildlife is an inherent threat to the food supply of livestock, Rubenstein explained.

These results could prove crucial to preserving animals that are increasingly threatened as the human demand for food drives the expansion of land used to raise cattle. Zebras and wild horses are especially vulnerable to the spread of pastures because of their abundance.

"Grazing competition from other animals has been an issue throughout history," Rubenstein said.

"There's a fear that if some other animal is eating grass meant for livestock, that hurts the rancher. Those perceived competitors were seen as vermin and exterminated," he said. "These experiments suggest that in certain cases cows can actually experience considerable advantages in terms of growth when allowed to graze with other species."

The Benefits Of Grazing

By Kate Campbell, July/August 2009 California Country magazine

Cattle grazing, and other good range management practices, can add greatly to the health and vitality of any landscape.

In the spring, California rangeland is carpeted with wildflowers and dotted with grazing cattle. In the fall, the grassy meadows look like brown velvet and wildlife rattles the chaparral.

Monterey County rancher George Work says the beauty of this ever-changing landscape is one of his greatest pleasures because he knows cattle grazing, and other good range management practices, can add greatly to the health and vitality of this important native landscape.

Through a variety of wildlife management techniques, the Work Family Ranch has more than 300 different species thriving there, including tule elk, which at one time were nearly extinct. Along with that, there are several hundred head of cattle and a small herd of horses.

"I grew up here and took over management from my father in the 1950s," Work said. "We've run cattle and farmed dryland grain and hay since the 1800s. In those days, exotic annual grasses began to take over, creating a significant impact on the land. And there were other forces—erosion, invasive plants and animals, as well as grazing practices—that left their marks."

Today the family manages the ranch using techniques very different than the ones employed by early California ranchers. These days the Works focus on a "whole system approach" that takes into consideration the needs of a complex environment.

To ensure a healthy environment in the future, the Works make decisions about the land based on how it exists today.

"Our family uses a holistic decision-making process that aims for outcomes that are ecologically sound, socially just and economically viable," Work said.

The cattle part of the family operation has undergone a dramatic transformation with the adoption of holistic management techniques, he says, explaining that seeing how all parts of the landscape work together aids in managing for a healthier environment.

Rather than raising cattle as an end in itself, the Work family, and many like them, now view cattle as a tool for good range management.

"Some years back we realized that we're not really in the cattle business," Work said with a chuckle. "That was a surprise. What we found is that we're really grass farmers. The cattle are just a way to harvest it and make a living."

To improve the grasses on his ranch, Work says they've combined herds to makes it easier to use the cattle in ways that benefit the range. This also provides recovery periods for the plants.

"But grazing isn't the only thing that impacts the range. A big problem we have in California is invasive species," he said. "Grazing is probably one of the most important tools we have for controlling things like yellow starthistle. Cows, sheep and goats all eat it."

A native of Eurasia, yellow starthistle was introduced accidentally sometime around 1849. Alvarez says it is by far the fastest-spreading and most-invasive nonnative plant the state has ever seen.

Work offers another example of how cattle improve the rangeland. To begin a habitat restoration project, the family used their cattle to knock down invasive, fire-prone brush and allow a greater variety of native plants to return. They tossed some alfalfa hay into the area they wanted cleared and turned the cattle in.

"In two feedings of about 15 minutes each, the hungry cattle crushed the brush with their excited behavior," he said. The trampled brush provided ground cover to prevent winter erosion from runoff and spring brought a resurgence of perennial grasses and tender sprouts, which was wonderful deer feed."

Ranchers agree that there's a change in the way people think about grazing, a growing recognition that, when done properly, there can be far-reaching benefits from this time-honored agricultural

"The philosophy for improving or restoring the environment used to be, remove humans, leave it alone and the land will go back to nature," said environmental activist and author Dan Dagget.

The problem with removing people and their food-producing activities from the land, he says, is that "humans are an important part of the very ecosystems we're trying to restore.

"Removing ourselves from (the landscape) dooms us," he said. "It's like trying to put back together an extremely complex puzzle with a very important piece missing—us."

practice. But, they also understand that past practices have done damage to the environment and created public concerns.

"Managed grazing, when it's done well, actually enhances the organic matter in the soil, improving its ability to store carbon," said Shasta County rancher Henry Giacomini, who is chairman of California Farm Bureau Federation's Public Lands Advisory Committee. "And, it improves the water and mineral cycles and allows the whole ecosystem to function in a way that's healthier.

"At our ranch we use irrigated pastures and concentrate the cattle, moving them every day. We monitor the condition of residual grass after we move them and watch to see how well the grasses recover after a rest.

"We use buffers along our creeks, ungrazed strips of grasses that can filter material running off the fields," he added. "That technique protects the stream banks from erosion and improves water quality.

Noting that grazing animals, including great herds of elk and deer, have been a vital part of the state's grassland ecology for thousands of years, Giacomini said Farm Bureau policy recognizes that grazing is the most practical and environmentally acceptable way to prevent the buildup of excessive, dry vegetation that can lead to catastrophic wildfires.

Grazing Offers A Bounty Of Benefits

Grazing animals can be an important factor in maintaining balanced and diverse ecosystems. Researchers say there are a number of very important environmental benefits from responsible grazing of public and private lands. Those benefits include:

Benefits To Plant Life

Open grasslands and woodlands are generally dominated by non-native and/or invasive annual grasses and herbs.

The vegetation, when left unmanaged, tends to inhibit the germination and growth of other plants by using up most of the available water and mineral resources in the soil and by producing large amounts of thatch.

Livestock grazing controls the growth of the non-native grasses and herbs so that other desirable plants (wildflowers and native grasses) can regenerate and coexist with them. Many plants, including several endangered species, require grazing to maintain viable populations.

Benefits To Wildlife

Well-managed livestock grazing increases the diversity of habitats available to wildlife species. Many species, including several endangered species, benefit form the vegetation management performed by livestock.

Ground squirrel colonies in grazed areas support the foraging needs of predators like bobcats and golden eagles and at the same time, recreate underground tunnels that are used by insects, reptiles, amphibians, and many small mammals. Burrowing owls, kit fox, and badgers occupy them as well.

Biomass Production

Hoofed animals play a major role in regulating primary production (energy produced by photosynthesis) in grazing ecosystems (Huntly 1991). Defoliation can promote shoot growth and enhance light levels, soil moisture, and nutrient availability (Frank et al. 1998). Overgrazing, however, can significantly reduce biomass production.

Seed Production, Dispersal, and Germination

Grazing animals can decrease flower and seed production directly by consuming reproductive structures, or indirectly by stressing the plant and reducing energy available to develop seeds. Grazing animals can also disperse seeds by transporting seed in their coats (fur, fleece, or hair), feet, or digestive tracts (Wallander et al. 1995, Lacey et al. 1992). For some plant species, grazing animals may facilitate seed germination by trampling seed into the soil.

Protection From Erosion

Organic components of feces and urine from grazing animals can build soil organic matter reserves, resulting in soils having increased water-holding capacity, increased water-infiltration rates, and improved structural stability. These changes can decrease soil loss by wind and water erosion (Hubbard et al. 2004).

Incorporating Organic Matter

The hoof-action of large grazing ungulates can incorporate plant material into soils and increase organic matter.

Ecosystem Processes

Grazing contributes to nutrient cycling and the food web.

Fire Hazard Reduction

Properly managed livestock grazing helps to reduce fire hazards by controlling the amount and distribution of grasses and other potential fuel.

Ponds developed for livestock watering support large numbers of breeding amphibians, which also feed on the abundant insect life found in the grasslands. Proper utilization of livestock grazing promotes healthier, diverse wildlife populations in parks.

Herbivores consume plant leaves, stems, flowers, seeds, and sometimes roots. Patterns of herbivory largely determine plant community composition, structure, and productivity.

Through hoof action, pawing, and wallowing, grazing animals trample plants, break up soil surfaces, incorporate seed into the soil, and compact soils.

Grazing animals contribute to nutrient cycling by depositing nitrogen-rich urine and dung, and their carcasses can provide an important contribution to the food web.

In human-controlled grazing systems, the detrimental or beneficial effects of grazing are largely determined by how and where grazing is used. The negative impacts of livestock grazing are often the result of misuse.

Grazers enhance mineral availability by increasing nutrient cycling within patches of their waste and increasing nitrogen availability to plants (Holland et al. 1992). In natural grazing

systems, the decomposing carcasses of wild animals provide feasts for decomposers and scavengers, constituting a central node in the food web (Dunne et al. 2002). However, in grazing systems managed by humans, livestock carcasses are often removed from the environment.

Grazing Can Alter Fire Regimes

Fire frequency, intensity, and behavior are dictated largely by type, condition, and quantity of vegetation (DiTomaso and Johnson 2006). Grazing alters fuel-load characteristics by changing plant community composition, structure, and biomass.

45.

Zero Budget Farming

All You Need Is One Cow

Zero Budget Natural Farming (ZBNF) or holistic agriculture is a method of agriculture that counters the commercial expenditure and market dependency of farmers for the inputs like fertilisers and pesticides.

The method involves locally obtainable natural bio-degradable materials like cow dung and urine and combine scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes.

Zero budget farming methods are promoted by agri-scientists like Subash Palekar and Masanobu Fukuoka.

It requires absolutely no monetary investment for purchase of key inputs like seeds, fertilizers and plant protection chemicals from the market. The farmer can grow hardy local varieties of crops without application of fertilizers and pesticides. Since it is a zero budget farming, no institutional credit would be required and dependence on hired labour is also reduced to bare minimum.

The whole philosophy behind this system is to make the farmer self-reliant so that he is not subjected to volatile market forces.

All that the system requires is a native breed of cow which in any case forms an integral part of farming in India's rural areas. It is claimed that one cow is sufficient to take up this method of farming on thirty acres of land.

Soil Is A Prefect And Complete System

Zero Budget Farming works on the premise that soil is a complete system in itself, independent and self-sustaining. Soil is perfectly capable of supporting life without any need for artificial inputs or technologies.

How much nutrients the crops takes from the soil? Only 1.5 to 2.0 % Remaining 98 to 98.5% nutrients are taken from air, water and Sun. Every green leaf is a food producing factory. It takes carbon dioxide & nitrogen from the air, water from the clouds and light from the Sun. Every green leaf produces 4.5 gram carbohydrates per square feet surface, from which we get 1.5 gram grains or 2.25 gram fruits. Neither air, nor cloud or Sun send us any bill for their contribution. All these inputs are available free of cost.

Green leaves do not use the technology of the Agriculture Universities or multinational food companies. Neither do the Sun, Moon, cloud and air depend on our technological inventions.

All these natural elements that go in our food production are available for free. Earth, water, air and light are freely available in all parts of the world. Where is the question of farming becoming a colossal industry, requiring billions of dollars in investment.

If this is all true, then what is the role of agricultural universities and multi-trillion dollar agribusinesses? What is the role of government subsidies and international trade agreements. Why

om purnam adah purnam idam
purnat purnam udacyate
purnasya purnam adaya
purnam evavasisyate

"The Personality of Godhead is perfect and complete, and because He is completely perfect, all emanations from Him, such as this phenomenal world, are perfectly equipped as complete wholes. Whatever is produced of the complete whole is also complete in itself. Because He is the complete whole, even though so many complete units emanate from Him, He remains the complete balance."
~ Sri Isopanisad

people have to starve when they can grow their own food with simple efforts in any part of the world.

A Forest is a proof of nature's prefect and complete system. Since time immemorial, forest eco-systems have existed, producing fruits, flowers, herbs and honey. No agricultural scientist was ever required to maintain these delicate system. Neither there was any need for chemical or organic fertilizers, insecticides, cultivation by tractor, irrigation or GMO seeds. Nature, when left to itself, takes care of everything. Even trees in our countryside produce fruits year after year without any attention on our part.

Experts admit that natural soils are rich in nutrients but they emphasize chemical fertilizers because these nutrients in their natural form can not be utilized by the plant roots. The plant roots can not make use of them in spite of their abundant availability. The soil testing report may say that there is enough Potash in the soil but it is in an unavailable form. So we have to add it from outside.

That is where micro-organisms and friendly creatures like earthworms come into picture. They convert soil nutrients from their non-available form to available form. Just like we can not eat wheat unless it is converted into a bread.

In a forest system, soil is teeming with micro-organisms and therefore their is no necessity of any external input.

However, in our modern farms these nutrients (in acceptable format) are not available because the micro-organisms who convert these non-available nutrients are destroyed by poisonous chemical fertilizers, insecticides, fungicides, herbicides etc. It's like if you don't cook at home, you have to get your dinner from a restaurant.

When soil's innate capacity to generate nutrients is impaired, we have to add artificial nutrients from outside.

If we want to avoid unhealthy restaurant food, we have to establish home cooking. Same way if we have to facilitate generation of nutrients within farm soil, then there will be no necessity of adding fertilizers externally.

How can we re-establish these micro-organisms in the soil? This is done by applying the cow dung of local cow. The cow dung of the local cow is a miraculous culture. As we add a spoonful of curd (culture) to a pot of milk , likewise the local cow dung is a culture for the whole field. One gram of cow dung contains about 3000 to 5000 million beneficial microbes.

How much cow dung is needed for one acre of land? Subash Palekar researched this subject for six years. He studied all Indian cow breeds like Gaulao, Lal Kandhari, Khilar, Deoni, Dangi, Nimari from Maharashtra; Gir, Tharparkar, Sahiwal, Redsindhi from West India; Amrutmahal, Krishna kathi from South India and Hariyana from North India. He tested the dung and urine of all these breeds on every crop, in each moon phase and constellation.

His first conclusion was that only dung from traditional local cows is effective, not from Holstein-Friesian breeds. We can mix half cow dung and half the dung of bullock or buffalo, but not of Jersey or Holstein at any cost.

Secondly, the cow dung and urine of black colored Kapila cow is most effective. Thirdly, the cow dung should be used as fresh as possible and the urine as old as possible. Fourthly, only one cow is needed for thirty acres of land. Farmer need not use any compost, vermi-compost for farmyard manure.

For one acre land, only ten kilogram of local cow dung is sufficient per month. One local cow gives on an average about 11 Kg of cow dung, one bullock about 13 Kg of dung and one buffalo about 15

Kg dung per day. For one acre one day's cow dung is enough. That means thirty days cow dung for thirty acres.

You can not imagine a forest without its fauna. To continually regenerate itself, a forest needs the excreta of the animals, birds, earthworms and insects. These inputs are necessary in any self-developing, self-nourishing system. That means the use of cow dung and urine is very natural and hence scientific.

Similar principal applies to this system of farming. Micro-organisms present in cow dung decompose the dried biomass in the soil and make the nutrients available to the plants. There is complete symbiosis in the nature. Jaggery is added in the mix to facilitate biological reaction.

The cow that gives more milk, its dung and urine are less effective and the cow that gives less milk, its dung and urine are more effective. *(Subash Palekar)*

Zero Budget Farming Preparations

Seed Treatment with Beejamrita

Composition:

a) Water 20 litres

b) Desi cow dung 5 kg

c) Desi cow urine 5 Litres

d) One handful of soil from the surface of field

e) Lime 50 grams

The above mixture termed as 'Beejamrita' can be used to treat seeds, seedlings or any planting material. The planting material has to be simply dipped in 'Beejamrita, taken out and planted. Beejamrita protects the crop from harmful soil borne and seed borne pathogens during the initial stages of germination and establishment.

Jeevamritam

Composition:

1) Water 200 litres

2) Desi cow dung 10 kg

3) Desi cow urine 5 to 10 litres

4) Jaggery 2 kg
5) Flour of any pulse 2 kg
6) Handful of soil from farm or forest -

The above mixture will suffice for one time application on one acre crop. 'Jeevamritam' is to be provided once in a fortnight or at least once in a month. It promotes immense biological activity in the soil and makes the nutrients available to the crop. Jeevamritam is not to be considered as nutrient for the crop but only a catalytic agent to promote biological activity in the soil.

Mulching

Mulching with organic residues or live mulching reduces tillage and consequently labour requirements, suppresses weeds, promotes humus formation and enhances the water holding capacity of the soil. Mulching enhances the biological activity and replenishes the nutrient base of the soil. Adequate mulching keeps the top and sub soil moist and enhances the water holding capacity of the soil and also reduces water loss due to evaporation so that the crop will be better equipped to tide over drought conditions.

Plant Protection

In the event of outbreak of insects and diseases the farmer can himself prepare home made pesticides and use it on the crops.

Fungicide-I
a) Butter milk fermented for five days 5 litres
b) Water 50 litres
Fungicide –II
a) Desi cow milk 5 litres
b) Black Pepper Powder 200 grams
c) Water 200 litres Insecticide- I
a) Powder of neem seed or Neem leaves 20 kg
b) Water 200 litres
Insecticide- II
a) Cow dung 5 kg
b) Cow urine 10 litres

c) Neem leaves 10 kg

d) Water 200 litres

This mixture is particularly effective against aphids, jassids, mealy bugs and white flies.

Insecticide – III

a) Neem leaves 10 kg

b) Tobacco powder 3 kg

c) Garlic paste 3 kg

d) Green chillies paste 4 kg

The above ingredients should be soaked in cow urine for ten days. About 3 litres of this mixture can be mixed with 100 litres of water and sprayed on crops.

The above mentioned fungicides and insecticides can be prepared by the farmer himself and used either as prophylactic or as curative measure for control of crop pests. If the economic injury to crops due to pests is less than five percent, it should be deemed to be 'return to nature' and no plant protection measures should be taken.

Mixed Cropping and Crop Rotation

Zero Budget Natural Farming advocates cultivation of diverse species of crops depending on site specific agro climatic conditions. Mixed cropping provides buffer against total failure of single crop and also widens the income source of farmers. There is stress on inclusion of leguminous crops to ensure replenishment of soil fertility. Crop rotation is also emphasized to discourage build up of endemic pests. In the scheme of mixed cropping, cereals, millets, leguminous crops, horticulture crops particularly vegetables and even medicinal plants can be included to make farming more lucrative.

The system also advocates wider spacing of crops to facilitate inter

cropping. Palekar has repeatedly stressed that just as diversity is the rule of nature, the farm should also have diverse species.

Observations And Inferences

By R.Yogananda Babu

Visit to fields where Palekar's Zero Budget Natural Farming has been adopted and interaction with farmers whose profiles have been collected, revealed that all of them were raising crops using modern technology of improved seeds, fertilizers and plant protection chemicals before adopting this new method. They found the old method to be very cost intensive and by their own estimates the cost of cultivation of one acre of paddy was Rs.5000/- to Rs. 6000/- and that of sugarcane Rs. 15000/- to Rs. 20000/-.

Similarly the cost of cultivation of one acre of banana was Rs. 25,000/- to 30,000/-. This often compelled them to raise loan from conventional and institutional sources. However, the returns were not commensurate with the investments made for raising crops. The produce from field crops generally met the requirements of the family and the marketable surplus was not sufficient to repay the loan. Market forces were also some times detrimental to the interests of the farmers resulting in low price realization. It was evident from interaction with the selected farmers that they practiced a form of subsistence farming.

In this bleak scenario all the farmers selected for study attended orientation courses conducted by Subhash Palekar at different places of Karnataka. They were convinced that zero budget natural farming is farmer friendly, eco-friendly and above all extremely cost effective. These reasons were cogent enough for them to give this method a fair trial and hence they switched over to this new method. The

experience of the practicing farmers and field observations over a period of time lends credence to the following conclusions.

a) The system of zero budget natural farming is eminently suited to the farmers, particularly small and marginal farmers because of its simplicity, adoptability and drastic cut in cost of cultivation of crops. The appeal to the farming community lies in the fact that maintaining optimum levels of production and keeping the cost of cultivation to the bare minimum will substantially enlarge the profit margin.

All the sample farmers acknowledged it as farmer friendly and financially viable. However during the initial period of transition to new system, the results may not be encouraging because of the lingering effects of chemical farming. The results will become evident only after adequate mulching and restoration of biological activity in the soil. Hence, patience and perseverance are required on the part of farmers.

b) Treatment with Beejamrita and Jeevamrita has given extremely encouraging results for successful cultivation of crops. Beejamrita does provide adequate protection to crops from insects and diseases during the initial stages of germination and establishment. Mortality in case of treated crop is reported to be almost negligible.

The experience of the farmers bears ample testimony to the fact that Jeevamrita promotes rapid and enormous biological activity in the soil. However, it should be coupled with adequate mulching so that the soil is transformed into humus rich reservoir of nutrients. It is also observed that providing Jeevamrita once in a fortnight is better than providing it once in a month. It has been the experience of farmers that dispensing with the use of fertilizers has not adversely affected crop yields. The use of home made pesticides has also been found to be effective in managing the crop pests without economic injury to crops.

c) Experience with this method of farming corroborates the fact that adequate mulching promotes humus formation, suppresses weeds and greatly reduces the water requirement of the crops. Live mulching particularly with leguminous crops has been found to be

not only a subsidiary source of income but also a safeguard against depletion of nutrients by crops.

d) Mixed cropping particularly with short duration legumes, vegetables and even medicinal plants has certainly expanded the income source of farmers.

Vegetables rich in vitamins and minerals are generally marketed after adequately providing for home consumption and this certainly augurs well for overcoming malnutrition which is widespread in rural areas. Mr. Bannur Krishnappa obtained an additional income of more than Rs. 15,000/- by planting Ashwagandha and Coleus in one acre as intercrop with sugarcane.

e) All the farmers selected for study have expressed satisfaction that switching over to the new method from chemical agriculture has paid them good dividends.

Savings on cost of seeds, fertilizers and plant protection chemicals has been substantial. Almost all the farmers have stopped borrowing crop loan. They are also not depending on hired labour as the family labour is sufficient to carry out all the farming operations. The yields have been optimal with possibly no decline in future, because of continuous incorporation of organic residues and replenishment of soil fertility. The new system of farming has freed the farmers from the debt trap and it has instilled in them a renewed sense of confidence to make farming an economically viable venture. This is a noteworthy feature in an era marked with farmers committing suicide across the country.

Following reports on the success of zero budget farming were published in India's national newspapers.

Zero Budget Farming A Success

The Hindu, April 30, 2010

"Modern agriculture is the use of land to convert petroleum into food. Without Petroleum we will not be able to feed the global population."
-Professor Albert Bartlett

For A.C. Joshykumar of Muttukad in Bison Valley grama panchayat employing zero budget natural farming methods in his seven-acre multi-crops land has proved successful with considerable increase in yield.

Joshykumar is one of around 45 farmers in the district who have already shifted to zero budget farming, devised by Subhash Palekar of Amaravathy in Maharashtra.

Mr. Joshykumar said he could easily shift to zero budget farming since he had always practised organic farming methods. He said that full dedication and keen efforts were needed to shift to zero budget farming .

Zero budget farming proposes that only a single cow is needed to cultivate 30 acres of land. It employs scientific methods to rejuvenate the micro organisms in the soil with the help of earthworms. Fertilizers or pesticides are not used in the method. The focus of the cultivation is through the activation of micro organisms in the soil.

Mr. Joshyjkumar said that his main cultivation, pepper, is completely resisting pest attack even though he was not using any pesticides and production has increased considerably. He bought an indigenous variety of cow- Jaboo - from Kasargod when he shifted to this farming method.

Cow dung is the main component used for revitalising soil with the help of dried plants, which is used to cover the ground around the cultivated plants.

Besides pepper, he also cultivates vegetables, nutmeg and clove. “An exporting agent from Marayur who markets organic produce bought clove from me at Rs.400 a kg when the market price was Rs.310," he said.

Another farmer, Sunny Kudankavil of Panamkutty said he got an yield of 400 kg from 5 kg of ginger rizhome since he shifted to

zero budget farming. "If you follow the guidelines suggested by Mr. Palekar, you will get the result," Mr. Kudankavil, who had attended a three-day workshop organised by Mr. Palekar said.

Though the Kerala Agriculture Development Society procures organic produce at 10 to 30 percent higher price, lack of a regular procurement scheme for organic produce is one problem faced by farmers, he said.

Jose Ammencheri, a cardamom farmer in Vandanmedu, said yield had not fallen when he shifted his 14-acre plantation to the new farming method. "There will not be a sudden increase in yield, but it sustains. Also, organic pest control methods are used," he said. Cardamom plantation is known for its high usage of pesticides.

V.C. Devasia said his cocoa plants and rubber plantation have shown higher yield since he shifted to zero budget farming three years ago.

Shaji Thundathil, who is co-ordinating the farmers engaged in zero budget farming, said that thousands of farmers were keen to shift to the farming method. He said that 300 acres of fallow grass land in Muttukadu would be cultivated using zero budget farming methods jointly by farmers, who have found success employing the method.

Zero-Budget Farming In Vithura, Kerala

The Hindu, Thiruvananthapuram, May 31, 2013

India's civilization was based on village residence. They would live very peacefully in the villages. In the evening there would be bhagavata-katha. They will hear. That was Indian culture. They had no artificial way of living, drinking tea, and meat-eating and wine and illicit sex. No. Everyone was religious and satisfied by hearing -- what we are just introducing -- Bhagavatam, Bhagavad-gita, Puranas, and live simple life, keeping cows, village life as it is exhibited by Krsna in Vrndavana.

-Srila Prabhupada (Morning Walk -- Durban, October 13, 1975)

Farming is no 'hobby' for Abu Dhabi-based businessman Rohini Vijayan Nair from Vithura. Realising that the rooftop garden at his flat in Abu Dhabi is just too small for his experiments, this agri-enthusiast has now taken up farming in 100 acres of land at his hometown here.

"I needed to do a little more than terrace cultivation and thus took to farming in 100 acres of rubber plantation last year," says Mr. Nair, who manages to juggle farming in Kerala and business abroad.

Thanks to his effort and willingness to take up farming amidst his busy schedule, the land is now full of medicinal and indigenous plants, tropical trees, and various fruit trees along with rubber trees. He has also taken up banana and cashew cultivation.

But unlike other farmers, this man wanted to make sure that his farming techniques did not, in anyway, affect the natural pattern of the soil and land. The search for a suitable farming method finally ended with the zero-budget natural farming advocated by noted agricultural scientist Subhash Palekar.

"The method involves using locally obtainable natural bio-degradable materials and traditional techniques to improve fertility. Though it is not 'zero-budget' here as many other factors such as the State's climate and the labour cost have to be taken into account, it is a highly successful model," Mr. Nair says.

Test Farm

And for those who need proof of how beneficial and environment-friendly the method is, Mr. Nair has a test farm. In three sections of this land, he has been using bio-fertilisers, chemical fertilisers, and 'Jeevamritam' (fertilizer used for zero-budget farming), separately.

"When visitors ask me how nature-friendly the technique is, I want to show them the results of the three types of farming, their pros and cons. When they see the test farm and the produce, they themselves will understand how profitable budget farming is," Mr. Nair says. He has now joined hands with the Krishi Bhavan and has dedicated 25 acres of his land for vegetable cultivation, expecting to reap the harvest during Onam.

46.

Cow Dung At Work

In New Zealand

Jon Morgan - Businessday, November 11, 2010

Ms Heather Smith, an American from the verdant eastern state of Vermont has made a home in New Zealand for the past 14 years. She lives at her picturesque farm in the shadow of Hawke's Bay's craggy Te Mata Peak.

She first heard about New Zealand as a university student in the 1980s.

She arrived in New Zealand in 1997, after working with groups in Vietnam, Taiwan, Hawaii and Alaska fighting to save endangered species, such as tigers and bears, and on habitat restoration projects.

Now, on her 275-hectare farm, she has a similar mission.

It is to help revive a way of life that she fears has been almost submerged by the drive for greater productivity at any cost.

She is concerned that farming is becoming too industrialised at the expense of the small family unit, of environmental and animal health and of urban shoppers' knowledge of where their food comes from and what goes into the making of it.

Her farm is an eclectic mix of sheep, cattle, chickens, feijoas, grain crops and truffle trees, all grown organically using the principles of early 20th-century philosopher Rudolf Steiner.

Known as biodynamics, the farming methods shun all synthetic chemicals, replacing them with compost and manure fertiliser nurtured in buried cow horns, and follow the phases of the moon and planets in planting crops.

"I know it sounds wacky," Ms Smith says, "but it works for me. *There's a feeling here of nature in balance. It's hard to explain, but there's a fragrance in the air – the trees, the soil, the animals, everything just smells right. People who come here tell me their souls feel so much better."*

She was travelling by train from Napier to Wellington when she first encountered biodynamics. Seated near her was a family with a bucket of worms. The worms were a gift from pioneering Kiwi biodynamics soil scientist Peter Proctor to the family. "I sat there with them for the whole five-hour trip, talking and learning. They were so smart, really into it."

Inspired by her encounter with the family, she began to learn more about biodynamics by reading and talking to practitioners.

With the help of farm manager Nick Radly, she gradually began to change the farm over to the new regime.

An essential part is the use of Steiner's Preparation 500, made by filling a cow horn with cow dung and burying it in autumn to be dug up in spring.

The cow horn is a keratin-rich container and it is filled with beneficial material from one of nature's most complex digestive systems. She describes the contents of the retrieved horn as fine, silky dirt. "It doesn't look like manure any more. It's full of beneficial fungi and bacteria."

A teaspoon of the preparation is stirred into 40 to 60 litres of warm water and sprayed on pasture to "kick the soil organisms into activity".

She calls on a science analogy to explain it. "It's like taking a swab from a strep throat and making a culture of the bugs in agar in a petri dish. On the farm, that's the cow horn of manure. In the dish, you can see the bacteria expand rapidly. And on the farm the same thing is happening when we've sprayed the bugs around. The difference is we're using good bugs."

The spray stimulates the soil biology, which leads to the growth of more nutrient-rich pastures, crops and garden vegetables and fruit, she says.

On her farm, this is seen in healthier animals and pastures. "The cows and sheep are more fertile, the sheep have less flystrike, I don't

This Solution Could Make Paddy More Resistant To Pests

The following was taken from the daily, The Hindu, October 22, 2009.

"Dilute one litre of cow's urine in about 5 litres of water, take paddy seeds required for an acre and tie them into several small bundles and dip them in the solution for half an hour then dry the seeds under shade before sowing. Using this method several farmers have been successful and able to record that the seeds have become more resistant to infestations from pest attacks!"

With a mindful application the farmers, may be able to avoid the cost of pesticides, delivering a less harmful product to the consumer at a cheaper cost!

need to worm the horses, thistle numbers have plummeted and the pastures hold on to water longer and stay greener longer in summer."

It meant they coped better in the recent droughts, not being forced to sell stock. A low stocking rate and more than 7000 trees for shade and shelter also helped.

The soil is dark, crumbly and full of worms. Grass roots go deep and a clay pan is gradually being broken up. "People who come here, curious about what's happening, dig a hole, look at my soil and go, 'Ooh, aah'," she says.

Other fertilisers are lime, a worm-based compost tea and a variety of composts made from horse, cow and sheep manure, food scraps, basalt dust and Steiner preparations using camomile to stop nitrogen from leaching, yarrow to help the absorption of potassium and sulphur, nettles to promote iron and magnesium, dandelion for silica and valerian for phosphorus.

She has 300 ewes and 220 cattle of varying ages and takes 150 dairy grazers at a time.

At weaning, the cattle are given a black walnut remedy to reduce stress. "Every year, it gets easier," Ms Smith says and adds with a laugh, "and this year I swear the calves ran from their mothers."

The feijoas are a big future hope. She sells them to a juicer and an ice-cream maker, getting $1.30 a kilogram for her organically grown fruit, as against 70 cents for conventionally grown.

"It's a gem of a fruit," she says. "It's made into juice and pulp and all through the process retains its unique taste character, much more than other fruits."

However, the local market is saturated and export sales are needed to grow the industry.

She has seen the demand for organic food grow enormously and is frustrated that more is not being done to encourage organic

farming. "It's crazy," she says. "The Government is allowing the science institutes to spend money on genetic engineering research when there's no demand for it. Why can't that money go into organics, which is in hot demand?"

She has a favourite saying: "We don't photosynthesise - we are what we eat. More and more people are coming to realise that. They don't want chemicals in their food. They want natural goodness."

Thirteen years on from her first experiments with biodynamics, she feels she is still learning.

"We're still in an establishment phase and I don't know how long that will last, but every year it is a little easier. There is a cost to it, though, and it can be difficult some years to keep your head above water."

An endless stream of wwoofers (Willing Workers on Organic Farms) flock her farm. "They're fabulous workers, so keen. They care so much for the planet and they come here to get back to nature, learn how to milk a cow, make cheese and bake bread - and hopefully spread the word as they travel. It's really inspiring."

47.

Story Of Life And Death

A Tale Of Two Farmers

Here we narrate the story of two farmers who live in the same area in south India. One is happy and prosperous and the other is broke and dead. This may shed some light on the satanic forces responsible for farmers genocide in India. These reports appeared in the press on the same day.

Lankan Farmers Take Lessons In Cow Based Farming

Decca Herald, February 11 2012

A delegation of farmers from Sri Lanka visited farm of natural farmer Ramesh Raju at Kurahatti, Karnataka India last week.

Raju has succeeded in reaping good yield by adopting natural farming. Instead of fertiliser and other stimulants, Raju uses cow urine, cow dung cakes and jaggery to increase productivity of crops like banana and sugarcane.

Sharing his success story with his Sri Lankan counterparts - led by Jayant Tilak on a study tour, Raju said he cultivated 50 tonnes of sugarcane on one acre of land, spending Rs. 30,000. He has already earned Rs. 50,000 by growing sub-crops like brinjal, chilly and others.

The sugarcane expected to be harvested in five months will help produce 50 quintals of jaggery. According to the prevailing price jaggery costs Rs 3,500 per quintal.

He advised the delegates to adopt natural farming as propagated by Subhash Palekar - invest less and earn more without depending on fertilisers or pesticides. "Already five workshops have been conducted in Sri Lanka. It was the workshop that aroused the curiosity of farmers and hence we are on a study tour. We will also urge the government to adopt natural farming to increase food production to meet the growing demand," he said.

The delegation included Sri Lanka Farmers' Association president Darshan de Silva and Subramanya Pillai among others.

Two Farmers Commit Suicide In State

Deccan Herald, February 11 2012

In India with small holdings and small scale farming, there is no better alternative to employing cattle in farming.

While ploughing, the oxen stride with gentle gait, not harming the surface of the earth, unlike tractors.

Even as they plough the land, the oxen defecate and urinate, fertilising the land.

Cattle Manure : organic manure, green leaf manure, earth-worms, and slurry manure with cattle manure bond with the nature and make the land fertile. They do not create the challenge of chemical waste.

99% of the pests in nature are beneficial to the system. Insecticides prepared from cow urine or well fermented butter milk do not affect these helpful pests.

Dung from one cow is adequate to fertilise upto 30 acres of land and its urine can protect upto 10 acres of crops from insects.

Two farmers, unable to repay debts, commit suicide in separate incidents on Saturday.

Venkate Gowda, 65, a resident of Hosakote village in Pandavapura taluk of Mandya district, committed suicide by consuming insecticide at his field in the morning. The villagers, who saw him writhing in pain, rushed him to the district hospital. However, the treatment was ineffective and Gowda was declared dead in the afternoon.

The farmer grew sugar cane, paddy and ragi on his three-acre field. He was depressed due to repeated crop failures, despite purchasing seeds from reputed companies.

He had availed a loan of more than Rs. one lakh from State Bank of Mysore. In addition to this, he had borrowed Rs two lakh from private moneylenders.

In Sira

Eeranna, 45, committed suicide by consuming insecticide at his farm at M Dasarahalli village of Sira taluk.

He died while being taken to the hospital. The number of suicides by farmers has risen to 12, following the drought in the taluk.

Disappointed after repeated crop failure, Eeranna set up a petty shop, availing a loan of Rs 15,000 from Canara Bank. Losses in business led him to try his hand at manure business.

He had availed loans from private moneylenders also.

Joys of Cow Based Farming

Indian agriculture has variety. There is no farm-product that Indians don't cultivate. This land grows all kinds of grains, pulses, vegetables, fruits, flowers, cotton and silk.

About 70% of Indian population depend on agriculture for their livelihood. Majority of them are small farmers, owning one or two acres of land.

Indian agricultural landscape is diverse and vivid – in land topology, soil type and quality, irrigation method and frequency of harvesting.

Cattle are integral part of this huge canvas of agriculture. We use oxen to plough, to pick and move harvested crops and in irrigation. Cow manure is used as fertiliser, and cow urine as insecticide.

Both Ramesh Raju and Venkate Gowda's villages are about 6 kilometers distance.

Now what is the differences between these two farmers?

The difference is in their methods of farming. And these methods make a difference of life and death.

48.

Cow Dung

On The Face Of Monsanto And Its Agents In The National Capital

In November 2012, Indian government told the Supreme Court in an affidavit that it could not achieve the goal of reducing the number of hungry people by half without taking recourse to genetically modified (GM) crops, which could herald the second green revolution in the country. The central government said GM crops would not only lead to increased food security but would also reduce pressure on land use.

The central government pronounced its position backing field trials of GM crops while junking the interim report of the court-appointed Technical Expert Committee (TEC) report, which had recommended a 10-year moratorium on GM crops field trials.

But what about the farmers who are growing much more per acre than Mosanto or its forefathers can ever imagine? They are being conveniently ignored by the mainstream agricultural establishment. Why not make their techniques available to the masses?

G. Nagarathanam Naidu is one such farmer, based in South India, in Hyathnagar mandal near Hyderabad. He is producing 15.5

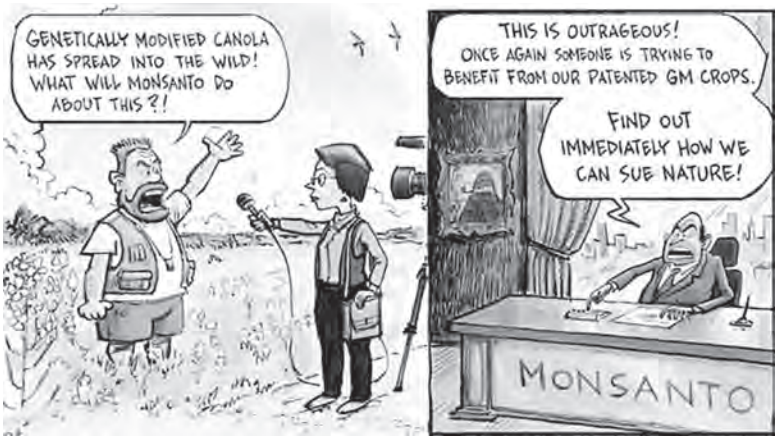
tons of rice per hectare by using indigenous cow based inputs in his field. His consumption of seeds, water, labour and other inputs is also much lower compared to other farmers.

Cropping System

- A combination of Zero Budget Natural Farming (ZBNF) and System of Rice Intensification (SRI)
- Application of farmyard manure (cow, sheep and goat manure) @ 5 tons/acre.
- Incorporation of Green manure and green leaf manure (Neem).
- Application of jeevamritham directly or along with farmyard manure to soil twice as top dressing.
- Using 2 kg seed for transplanting one acre, instead of 30 kg normally used.
- Planting 12 day old seedlings.
- Planting at 25x25cm spacing.
- Running three Row Cono weeder four times.
- Adopting alternate wetting and drying
- Controlling pests and diseases with bio-dynamic formulations, neem kernel
- Formation of irrigation channels round the field and for every 2 meters which are interconnected to save on irrigation water.

Jeevamritham Composition:

10kg cow dung



10 lit of cow Urine
0.5kg cow ghee
1kg jaggery
200g virgin red soil
Mixed in 200 lit of water

Application of bio-fertilizers (Azospirillum, Azotobacter, Phosphorus Solubilising bacteria) along with farmyard manure as top dressing.

Benefits

- Radical improvement in the soil health.
- Saving larger quantities of seeds i.e., 28kg seeds per acre
- Saving of irrigation water by 40% compared to conventional practice
- Higher yields for national food security.
- Overall cost of cultivation reduced by 25 percent.
- Increases yields by 30 percent over conventional practices.

G. Nagarathanam Naidu hails from a remote village Balakrishnapuram in Chittoor district, Andhra Pradesh. After obtaining his diploma in electronics, he was settled in a job. But that could not satisfy his innate desire to be connected with the land. It was then he and his wife decided to acquire 17 acres of barren and rocky land on the outskirts of Hyderabad. They could not afford better land.

The couple converted their new land into a gold mine by sheer hard work. They now have a mini forest with its own micro-climate. They also practice floriculture and grow varieties of exotic fruits and other crops.

He travels to different parts of India to train other farmers. Students from various schools and colleges also visit his farm to learn something about natural farming.

Awards And Appreciations

Various dignitaries have visited his farm which include scientists from various countries and Chief Minister of Andhra Pradesh.

When the former US President George Bush visited India, he was allowed to interact with him as a farmers' representative.

In 2005, he received appreciation from the WWF international Project. In 2007, he was given a certificate of appreciation by Association for Land reforms and Development, Dhaka, Bangladesh. In 2008, he was give a letter of honor by ICRISAT for implementing organic farming practices in groundnut cultivation and generating a record yield.

Also he received a Letter of Appreciation from Jara Agro Industrial PLC, Ethiopia, in the year 2011 for his sincere efforts in educating the local farming community on high yield strategies and innovative techniques.

Recently he was honored as the "Best SRI Farmer" by WWF Netherlands in collaboration with ICRISAT.

Section - VII

Stop Eating Beef

Beef Is Killing The Planet

49.

The Greenhouse Hamburger

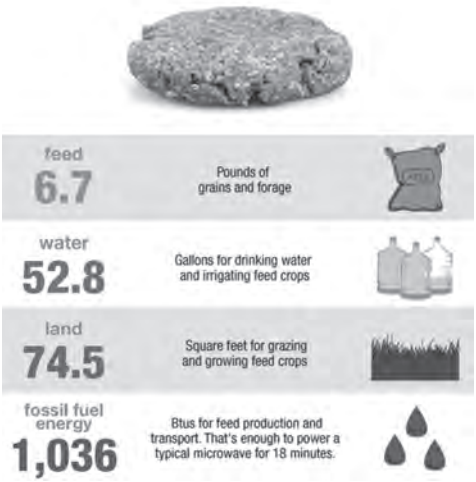
Producing beef for the table has a surprising environmental cost: it releases prodigious amounts of heat-trapping greenhouse gases.

Most of us are aware that our cars, our coal-generated electric power and even our cement factories adversely affect the environment. Until recently, however, the foods we eat had gotten a pass in the discussion. Yet according to a 2006 report by the United Nations Food and Agriculture Organization (FAO), our diets and, specifically, the meat in them cause more greenhouse gases—carbon dioxide (CO2), methane, nitrous oxide, and the like—to spew into the atmosphere than either transportation or industry. (Greenhouse gases trap solar energy, thereby warming the earth's surface. Because gases vary in greenhouse potency, every greenhouse gas is usually expressed as an amount of CO2 with the same global-warming potential.)

The FAO report found that current production levels of meat contribute between 14 and 22 percent of the 36 billion tons of "CO2-equivalent" greenhouse gases the world produces every year. It turns out that producing half a pound of hamburger for someone's lunch—a patty of meat the size of two decks of cards—releases as much greenhouse gas into the atmosphere as driving a 3,000-pound car nearly 10 miles.

In truth, every food we consume, vegetables and fruits included, incurs hidden environmental costs: transportation, refrigeration and fuel for farming, as well as methane emissions from plants and animals, all lead to a buildup of atmospheric greenhouse gases.

Take asparagus: in a report prepared for the city of Seattle, Daniel J. Morgan of the University of Washington and his co-workers found that growing just half a pound of the vegetable in Peru emits greenhouse gases equivalent to 1.2 ounces of CO2—as a result of applying insecticide and fertilizer, pumping water and running heavy, gas-guzzling farm equipment. To refrigerate and transport the vegetable to an American dinner table generates another two ounces of CO2-equivalent greenhouse gases, for a total CO2 equivalent of 3.2 ounces.



But that is nothing compared to beef. In 1999 Susan Subak, an ecological economist then at the University of East Anglia in England, found that, depending on the production method, cows emit between 2.5 and 4.7 ounces of methane for each pound of beef

Pound for pound, beef production generates greenhouse gases that contribute more than 13 times as much to global warming as do the gases emitted from producing chicken. For potatoes, the multiplier is 57.

Beef consumption is rising rapidly, both as population increases and as people eat more meat.

Producing the annual beef diet of the average American emits as much greenhouse gas as a car driven more than 1,800 miles.

they produce. Because methane has roughly 23 times the global-warming potential of CO2, those emissions are the equivalent of releasing between 3.6 and 6.8 pounds of CO2 into the atmosphere for each pound of beef produced.

Raising animals also requires a large amount of feed per unit of body weight. In 2003 Lucas Reijnders of the University of Amsterdam and Sam Soret of Loma Linda University estimated that producing a pound of beef protein for the table requires more than 10 pounds of plant protein—with all the emissions of greenhouse gases that grain farming entails. Finally, farms for raising animals produce numerous wastes that give rise to greenhouse gases.

Taking such factors into account, Subak calculated that producing a pound of beef in a feedlot, or concentrated animal feeding operation (CAFO) system, generates the equivalent of 14.8 pounds of CO2—pound for pound, more than 36 times the CO2-equivalent greenhouse gas emitted by producing asparagus.

Even other common meats cannot match the impact of beef; It is estimated that producing a pound of pork generates the equivalent of 3.8 pounds of CO2; a pound of chicken generates 1.1 pounds of CO2-equivalent greenhouse gases. And the economically efficient CAFO system, though certainly not the cleanest production method in terms of CO2-equivalent greenhouse emissions, is far better than most: the FAO data I noted earlier imply that the world average emissions from producing a pound of beef are several times the CAFO amount.

Solutions?

Scientists say that if we reduce the amount of meat, and especially the amount of beef we eat, even by a couple of meals a week there would be a huge difference in greenhouse gases released. For example, according to Dr. Christopher Weber, a researcher at Carnegie Melon, if we did not eat red meat or dairy products for one day per week, it would have the same impact greenhouse gas emission reduction as driving 1,500 less miles per year.

Individuals can reduce the effects of food production on planetary climate. To some degree, after all, our diets are a choice. By choosing more wisely, we can make a difference. Eating locally produced food, for instance, can reduce the need for transport—though food inefficiently shipped in small batches on trucks from nearby farms can turn out to save surprisingly little in greenhouse emissions. And people need to give up on meat, particularly beef.

The take-home lesson is clear: we ought to give careful thought to diet and its consequences for the planet if we are serious about limiting the emissions of greenhouse gases.

Source:

Nathan Fiala , Scientific American February 2009

Gerber, P. J., H. Steinfeld, B. Henderson, A. Mottet, C. Opio, J. Dijkman, A. Falcucci and G. Tempio. 2013. Tackling climate change through livestock - a global assessmaent of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations, Rome.

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Life Is Nothing But Time – Time Is Life, Life Is Time

An Inch of Time Can Not Be Bought With A Mile of Gold

Lost Time Is Never Found Again

(More information on availability on DrDasa.com)

Environmental crisis is for real and it's coming around faster than you think. It's not a brainchild of some conspiracy theorist but a tangible, perceivable fact, proven by the catastrophic events all over the world.

But for most of us, caught up in the daily grind, it's hardly a subject worth pondering over. Common man in the streets of London, New York or Delhi has very little time to worry about some ozone layer up there or some damn iceberg in the North Pole. At best, it is a snow bear's problem.

But the scientific fraternity and many political leaders don't think so. They are waking up to the horrors of global warming and climatic change. Hectic efforts are on to contain the damage but with very little success.

This book provides a simple solution to this grave crisis which has the potential to wipe out life altogether. This is a calamity of unprecedented proportions coming our way and a point of no return for the industrial civilization.

One of the arguments sceptics throw back at you is that the climate has always changed, and that is absolutely right. It's the rate of change that is the problem right now. It's changing so quickly that it exceeds our adaptive capacity.

We are in a hole and it's time to stop digging.

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