This document has inputs from:

- **Dr. Ranil Senanayake's Island article and CDW's comments interspersed in RED**
- **Dr. Kirti Tennakoon's analytical model of an isolated eco-system**

Ranil Senanayake <frsenanayake@gmail.com>
To:B.F.A. Basnayake
Cc:anawicks@outlook.com,Parakrama Waidyanatha,chris dharmakirti,Nimal Chandrasena,Gamini Seneviratne
Mon., Dec. 13 at 9:27 p.m.

Dear all, I think you have missed out the fossil energy subsidy to sustain the 'Green Revolution' and its impact on climate change.

[CDW- Agreed.

However, I think most of urea produced in France uses electricity from nuclear reactors. Germany is moving to use solar energy. Some farmers may decide to limit crops that need a lot of nitrogen, like maize, and turn to less demanding ones like spring barley or sunflower seed. Fertiliser prices have more than trebled over the past year, which bring costs for farmers to between 300 euros ($346) and 350 euros per hectare of cereal, compared with about 150 euros per hectare spent currently.

]

Also I fear that with the NPK mindset you might have also missed the need for 'remineralization'

.

[CDW- Thanks. Remineralization was addressed several times in our discussions although perhaps the word was not used!

Minerals are not lost due to addition of N, P, K, but due to (i) removal of matter as harvest, and this occurs in every agricultural system (b) excessive use of water, tiling and ploughing etc., which loosen the earth, and soil erosion and run off. (c) In pure 18th century agriculture where no external inputs except water were used, they still had to leave the land fallow and burn the "mukalaana" to re-mineralize when re-starting the chena.

See Captain Robert Percival's account of Kandyan agriculture in the late 1790s.

So, soil remediation, re-mineralization etc., are needed periodically in EVERY agricultural system except where it is purely hydroponic.]

I present one aspect below.

Best wishes,

Ranil

What is ‘Organic Agriculture’ and why is it important?

- Published on November 16, 2021

Ranil Senanayake

Organic Agriculture can be summarized simply as ‘Systems of agriculture that produces food and fiber free from industrially produced chemicals.’
[CDW- “industrially produce”, Ranil mentions this question later on, but let me raise it at the outset.
So anything using pumps, even steam engines that burn coal or wood, or fossil fuels cannot be used and we should only use tools prior to the industrial revolution? Solar panels cannot be use as it needs the supporting high-tech silicon industry etc etc? Mined materials also cannot be used as mining uses tractors and earth moving equipment powered by fossil fuels.]

It encompasses minerals, salts from natural sources, but the basic clear requirement is freedom from industrial chemicals such as fertilizer salts, herbicides and pesticides . There are many variations of agricultural practice worldwide which operate on this basis. Examples being, Biodynamic, Certified Organic, Natural Farming etc.
The distinction between organic and not organic, has its roots in the current dilemma facing food production through agriculture. Should we demand maximum production from land or optimum long-term management of resources?

[CDW- It depends on how you define “optimum”. Most agricultural systems have to satisfy the capacity to feed its target population for the foreseeable future (at least two decades) as the **number one** criterion.]

If maximum, levels of production are required, the system has to be boosted with external input until the natural system is replaced with a new energy dependent system, but these levels of production cannot be maintained without a constant input of external energy. Thus, organic agriculture, rejecting industrially produced chemicals, are constrained to the natural levels of productivity that can be optimized, without requiring a constant input of external energy.
It is this component of external energy used to increase productivity of crops that needs careful examination. The external energy component of agricultural systems that relies on industrial chemicals is usually very consequent and based on fossil fuels. In addition, it is fossil energy that drives the tractor and creates fertilizers, pesticides and weedicides. The burning of fossil fuels to

power such a production system adds greatly to climate change and impacts future productivity through Global Warming.

Does this mean that organic farming should all be done without machinery?

[CDW, this is the question I asked at the start. Here the question is asked, but NOT clearly answered.]

These concerns should also be addressed, as the current 'agricultural development' processes has been seen to increase the fossil energy percentage of all industrially produced food, adding to the climate change burden of each country

Thus, the idea that Organic Agriculture can be defined as 'Systems of agriculture that produces food and fiber free from industrial or fossil derived chemicals', has true value higher than those of quality and sustainability. It identifies an adherence and response to the global demand to reduce substantially the fossil carbon footprint in food production. To understand how industrial farming affects the Earth and why it affects sustainability.

In any debate on agriculture the complexity and value of a living agricultural soil needs to be understood. To many of us soil is the stuff that holds trees up. We see it as a solid surface for us to walk, ride or construct upon. Its usefulness in our daily lives, extends far beyond providing a substrate and nutrient for our crops; on closer examination this 'solid mass' of soil is home to thousands of species , it acts a sea to billions of organisms that live in it.

Soil is also the biological filter that detoxifies a large proportion of the poisons that we throw into the environment we live in. It is an underground living world as complex as, and most certainly older than, the world that lives on its surface. It covers most of the land surface of the planet, it is in a very real sense the 'living skin' of our planet.

The world of soil is bizarre to those of us who live on the surface. It is opaque to light and mostly solid and impenetrable. Communication is by chemicals, e.g.. pheromones or physical, e.g.. vibrations. Movement is slow, the faster organisms like the worms are the giants of this world, tunnelling through at a fairly rapid rate measured in centimeters per minute. More common are the fungi who move by growing through the soil at rates measured in centimeters per month, or the bacteria which have rates measured in centimeters per year.

It is a busy world, one gram of ordinary farmyard soil can contain over 1 billion individual bacteria, over 100 million individual actinomyctes and over 1 kilometer of fungal hyphpae, notwithstanding plants like algae and animals like collembolids, nematodes or worms. The estimates of the mass of living organisms in a fertile living soil is estimated at about 10,000 to 14,000 Kg per hectare. This is the key for agriculture that support mankind for millennia.

[CDW- it supported mankind very poorly and precariously for millennia.
Soil is both bad and good for humans. It produces worms, disease bearing organisms, mosquitoes etc. I mentioned all that in my reply to Dr. Premakumara. Bodhi Dhanapala also pointed out naturally produced viruses and fungus and insects; nature is neutral to any organism, and organisms have to adapt to the environment and also modify the environment (as sea coral or white ants do). We humans have gone one step further and know how to use machines and industry, which are what Se. Ranil S doesn't like]

A good soil with a mass of living microorganisms amounting to over 8000 tons per hectare, represents an energetic input equivalent to about that supplied by twenty horses or twenty horsepower of energy, applied 24 hours a day. It is this energy spent on natural soil chemical transformations that supply the energy to maintain a healthy soil ecosystem. In traditional farming systems, the addition of compost, green manure, cultured microorganisms etc., was used to enhance the natural fertility of a field. Some such approaches have produced noteworthy results, but none could produce the crop levels achieved through the artificial input of industrial chemicals. However, this increase has a tremendous cost, that will ultimately impact the sustainability of food production and human well-being.

[CDW- indeed the current rate of crop production is too big a demand on the natural system, and we need to either cut down the population or find a new technology. Adrian Mueller, a lead researcher at the famous Swiss Institute of Organic agriculture, looked at the organic model that Dr. Ranil Senanayake is describing, and concluded that if we are to use organic agriculture and feed the world, then we need to (a) cut down the world population to about 3.5 billion, and get all those people to become vegetarians, as producing meet is ecologically unsustainable. I discussed all this in
http://dh-web.org/green/CD-Mueller-OrganicL.pdf
Dr. Waiyanatha and Bodhi Dhanapala have also written similar articles to the Island newspaper. So, Dr. Senanayake needs to face this issue of how to reduce world populations, and how to get them to become vegetarians, if we are to go organic.
Unfortunately, we can't even get people to get vaccinated against a pandemic. So while we sympathize with the idealism and philosophy of Dr. Senanayake's stand, we have to be realistic.]

The hidden costs of industrial chemicals being applied to the ecosystem, irrespective of its cost to climate stability, is its cost in soil biomass and biodiversity loss. There is an ecological axiom that states 'energy flow through an ecosystem, tends to organize and simplify it'. When high energy industrial chemicals are applied onto the soil, many species of biota are lost and its biomass gradually decreases. The huge mass and diversity of soil microorganisms is gradually reduced until finally, the natural productivity of the soil is lost through attrition and it cannot produce without a further input of industrial chemicals. The living soil has been lost and the farm has become addicted to the additional energy of industrial chemical in order to produce a crop. Industrial chemicals are produced with their huge carbon footprint being absorbed by the subsidies extended to fossil energy products by global governments. The cost to the global commons is internalized by each nation and untaxed. The impact of this subsidy is being felt today at the farm level and has set up the challenge between organic (non-fossil dependent) and industrial (fossil dependent) agriculture.
[CDW- all that is well understood. Not only does increased energy flow reduce the structure to comply with the applied energy scale, but it also makes monocultures etc., more attractive. **But all this has been forced on the planet due to a huge**

and over-arching monoculture, which is the huge world population. That is why Adrian Mueller wants the world population reduced to half as part of going organic.]

By clarifying the meaning of organic agriculture we will facilitate the distinction and appreciation of differences that exist between the two systems. The easy part is to identify the practice of Organic Agriculture as 'Systems of agriculture that produces food and fiber, free of industrial chemicals.' The more difficult task is to standardize the plethora of bureaucratic demands surrounding organic certification, to farmers that 'prove' their authenticity in order to access the 'Organic 'market. In agriculture, It has been clearly demonstrated that 'sustainability' and mitigating Climate Change impacts depend completely on reducing their fossil Carbon footprint.

[CDW- the climate change danger will be more adversely affected if we go to organic agriculture. Composting increases CO2 and methane emissions. Using microbial fertilizers that enhance soil microbial activity also increases soil CO2 out puts.

The nitrogen fixed by soil micro-organisms do get converted to nitrates and other reactive nitrogen species in the soil before absorption by plants and the emission of reactive N-species from such soils has not been adequately investigated.

When ten tonnes of compost are loaded onto one hectare of tropical land, the monsoons and rains carry off huge amounts of organic matter and de-oxify aquatic systems and threaten aquatic life.

So, even in temperate Massachusetts there are now new laws governing Organic farms. As the output from organic farms is low, you need to open more land and more water to feed the people even at subsistence level.

If not for the Haber process, according to Prof. Smil Vaclav, "with average crop yields remaining at the 1900 level, the crop harvest in the year 2000 would have required nearly four times more land and the cultivated area would have claimed nearly half of all ice-free continents, rather than under 15% of the total land area that is required today". Unfortunately Dr. Senanayake never refers to the issue of feeding 7 billion people.]

Thus, Organic agriculture has a huge role to play in adapting to the oncoming changes in the global climate

[in making it an order of magnitude worse]

, while industrial agriculture must bear its global responsibilities and pay the costs of production that are currently internalized due to subsidies extended to it. The signs emerging from a warming planet suggest that, a return to hyperlocal forms of economy, will be essential for adapting to climate change, here, Organic Agriculture can play a pivotal role.

Kirthi Tennakone <ktenna@yahoo.co.uk>
To:B.F.A. Basnayake,Ranil Senanayake
Cc:anawicks@outlook.com,Parakrama Waidyanatha,chris dharmakirti,Nimal Chandrasena,Gamini Seneviratne
Mon., Dec. 13 at 11:44 p.m.

Sustainable organic agriculture is good , if we can meet the food requirement that way. Unfortunately I find it extremely difficult and constrained for the following reason

Consider an isolated ecosystem from which we harvest biomass at a constant rate R. If N is the weight of biomass per unit area . The rate of growth is represented by the logistic equation.

$dN/dt = kN – aN^2$ (1)

If biomass is harvested at a constant rate R

$dN/dt = kN – aN^2 - R$ (2)

System is in equilibrium, when $N = k/2a$, giving the maximum possible harvest rate

$R = k^2/4a$

R cannot exceed ($k^2/4a$). Furthermore you are removing mineral nutrients from the system at a rate proportional to ($k^2/4a$). These will have to be replenished at a cost of energy and materials. The rate of demand for food (proportional to R) is very high. Nutrient deficiency decreases the value of the parameter k. Replenishing the system with nutrients will degrade the environment.It is extremely hard to meet these constraints and feed the world population without concentrated fertilizers

.Kirthi Tennakone

CDW- If one includes the microorganisms in the soil, and claim that they can be used to fix nitrogen, "**mine the soil**", and also dissolve the phosphates, sulphates etc., found in the soil, the model can be made to generate a sustainable system. In fact, you can set up the model to do what ever you want. Buy such models are extremely valuable and must be developed. And calibrated with experimental inputs.

Kirthi Tennakone <ktenna@yahoo.co.uk>
To:Chandre dharma-wardana
Tue., Dec. 14 at 4:09 p.m.
Dear Ranil Senanayake

Thanks. An alternative to the idea (kinetics) is thermodynamics approach. The order in a closed system cannot be increased without and external source of energy. We have solar energy (plants use it and excess for our use), Unfortunately with present day technology N-fertilizers are not produced using solar energy. Hydrogen for the Haber process comes from fossil fuels. The real problem of nitrogenous fertilizers is CO2 emissions not toxicity. Technology has been initiated to use solar electrolytic hydrogen for Harber process.(Australia and India already have plans). This is probably the only avenue to feed the world population in future saving carbon emissions.

Kirthi Tennakone