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Regenerative farming: Can the Theory of Constraints contribute to its success? The Theory of Constraints perspective and intro to the RegenAg TOCICO SIG.

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Introduction

An application of the Theory of Constraint (ToC) seeks to identify a lever for significant performance improvement of a system and then develop the decisions to maximise the use of the lever and subordinate the rest of the system to these decisions.

This document will show that regenerative agriculture is an application of ToC, and that ToC thinking can be used to enhance what has been achieved already. It also serves as an introduction for the TOCICO RegenAg SIG

The first step in the search for a lever is to define the boundaries of the system, then to define the system's goal and to measure improvement in terms of goal units.

The natural system that we are part of as living organisms is finite. Therefore, there must be a system constraint, the lever. We should be able to apply the 5 focusing steps of ToC to devise ways to improve the performance of the system relative to its goal.

The earth and its atmosphere as the system and its goal?

The earth and its atmosphere are a subsystem of the solar system, which is a subsystem of the cosmos, and is the one planet that we know where life exists. Carbon is the foundation of all this life and carbon atoms cycle continually between gases (mainly carbon dioxide CO²) in the atmosphere and the soils and rocks and liquids in the earth, a flow. It is believed to be a closed system; the amount of carbon does not change, a closed circular flow. This is a physical natural flow from sources to sinks and does not have a goal other than striving to be in balance.

This system seems to experience a problem of surplus and shortage at this moment in time, too much carbon in the atmosphere and not enough terrestrial.

Donella Meadows estimated in Limits to growth: The 30-year update, that the overshoot was 1.2 Earths in 1999. It is now (2021) estimated to be 1.7 Earths. 1 August was earth overshoot day in 2024. (earth.org). The rest of the year we are in deficit.

A goal therefore could be to restore this balance as soon as possible.

What is the Core problem?

Many possible candidates can be listed, but let's employ effect-cause-effect thinking and flow analysis to decide. We know all the UDE's, and let's assume balanced carbon flow is the goal.

Too much carbon in the atmosphere has an insulating effect that leads to the earth warming, that leads to extreme weather that often threatens life. A warmer earth also leads to higher soil temperatures that cause vegetation and soil drying out faster and increasing instances of

fires that release more carbon into the atmosphere, that leads to a warmer earth. More and more species perish from the heat, the ice caps melts and sea levels rise threatening life in low lying areas. Global warming could reach a tipping point that changes dramatically the fragile environment all life depends on.

What are the sources of too much carbon in the atmosphere? One major source is the exponential increase in burning fossil fuels over the last century to produce energy for a growing population that consumes more and more.

Allan Savory proposes another major cause, the desertification of soil of two thirds of the earth's land surface caused by deforestation, industrial crop farming practices to feed the growing population, livestock farming practises such as feedlots (where cattle consume the crops produced at scale and more methane is emitted from the accumulation of dung) and continual grazing leading to over grazing of grasslands causing more bare earth. A vicious negative cycle.

Both are major new human created sources, manifested in the recent past, and the effect is that sinks of carbon is overwhelmed. This is the core problem.

Direction of a solution.

So, what is the direction of the solution? Reduce the sources or improve the sinks? Or something else? Or both?

The current focus is to reduce the sources through moving away from burning fossil fuels for energy to renewable energy sources like wind, solar, geothermal, hydro and nuclear. But is this not also increasing the source of carbon in the manufacturing of these machines.

The carbon footprint during the life cycle of solar panels and wind turbines seems to be a few orders of magnitude less than coal and gas fired power plants measured in grams of CO² equivalents per kWh (between 5 and 26 vs between 435 and 1690). The carbon payback of a wind turbine could be as little as 7 months. So, yes, it produces much less carbon than the burning of fossil fuels, but it will take years before renewable energy replaces energy generated from fossil fuels. Wind and solar now has the lowest levelized cost of energy as expressed in cost per megawatt hour, but an advanced wind turbine produces about 2.5 MW whereas a modern coal fired steam turbine about 700MW. The movement towards renewable energy sources is effective in slowing down this major source, but it will require many years of sustained effort, large investments and political will.

What about improving the performance of sinks? Oceans are a major sink and is working effectively but there are signs that it is acidifying, reducing its effectiveness, and impacting the ocean ecosystem. There is no technology yet devised that can improve the performance of the ocean as a sink.

A small study published in the American Journal of Climate Change in 2019 (American Journal of Climate Change Vol.08 No.02(2019), Article ID:91637,16 pages) reported "a significant increase 'in carbon sequestration' in as few as 2 years of farmers adopting regenerative

agricultural management practices in seven different soil textures, removing an average of 425 to 1584 lbs of atmospheric carbon/acre/year in the coastal plains of Southern Carolina". A mean increase of 2384 lbs/acre or 2670 kg/ha of soil organic matter.

The direction of a solution is now clear, focus on improving soil health.

This is not something new. Many farmers have been practising regenerative farming for decades with proven significant increases of organic carbon in the soil resulting in increased yields and profits.

Regenerating soil reduces the carbon flow from a major source, it reverses desertification, and it increases the effectiveness of a major sink, and it does not require large investments. But it does require a large shift away from industrialised farming.

Can this be done on a large enough scale so that we can remove a significant amount of carbon from the atmospheric excess?

Commercial system to improve

The commercial system to improve is a farming enterprise and its value chain, starting from the land and soil available and ending at the consumer of food produced. The goal of this system is to make more money now and in the future. The flow, however, experience very high variability in the weather, hail, rainfall, droughts and floods and fluctuating market prices with constantly increasing costs of inputs. The price of these inputs, fertilizer, fuels, pesticides, herbicides, etc. is constantly increasing. Most of the world's farms are therefore not profitable and farmers only survive because of government subsidies in various forms.

What is the constraint or limiting factor of this system? It depends on the farm and farmer. It could be cash, the available land, water, seed, demand or selling prices. The bottleneck is wandering.

Soil health as the strategic system's constraint.

Regenerative farming recognises the health of the available soil as the strategic constraint of the farming system. The one thing that determines the finiteness of farming and the performance of a farm.

The decisions to exploit the system's constraint must be focused on what is necessary to improve the health of soil leading to improved soil productivity. The exploiting decisions are to not plough, keeping the soil always covered, having living roots as long as possible, increasing biological complexity, and using planned livestock grazing to stimulate plant growth and naturally fertilise, the principles of regenerative farming.

The logic is that organic carbon in the soil increases because of more microbial life creating a soil carbon sponge (the soil actually feels spongy when walking on it), causing better water cycles, supporting more biological diversity, and more healthy soil, resulting in the dramatic

improved yields per hectare of available land over a few seasons through the virtuous cycle that is created.

Everything else however needs to be subordinated to these decisions, principally to not waste anything that are produced and adding more value to everything that flows to the consumer.

Profitability

All the essential inputs necessary to produce food on a farm are freely available – water, minerals, seed, energy – from rain, air, previous harvests, the sun, and the soil of the available land.

In ToC, Throughput is defined as the rate at which money is made by an enterprise. It is the difference between sales revenue and truly variable costs, all the input costs in farming, the difference between the money that flows in through the sales of produce and the outflows to suppliers. Farmers understand this well.

The goal units per constraint unit of a farm can be expressed as Throughput per ha/acre. It increases when input costs are more and more reduced as the soil becomes healthier, more products are produced from the same land and better prices are achieved for more nutritious and better quality products. If it is possible to sell more directly to consumers then the selling price increases significantly. The produce is de-commoditised.

The potential for more and more Throughput/ha of farms with regenerative farming is huge while at the same time sequestering more and more carbon in the soil. There is no upper limit discovered yet.

A paradigm shift from industrial farming to regenerative farming on a large scale could be the way forward for food production, farm profitability without financial support as well as dealing with many environmental problems.

Conclusion

The goal of TOCICO is to use ToC to improve the world through finding solutions to hard problems. Regenerative agriculture is a solution to a hard problem.

The RegenAg Special Interest Group at TOCICO therefore has the aims to:

1. Learn how to best support regenerative farmers in increasing the Throughput per ha of their farms, worldwide.
2. Share experiences of using TOC to improve T/ha.
3. Learn how to get premium prices in existing supply chains or selling direct to the consumer. An UFO to a meat trader for e.g.
4. Developing a S&T tree for risk free transition from industrial farming to regenerative farming.