Assessing healthy food chains

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Abstract: *There are many signs of crisis in the current food chain. The treadmill of innovations from which only top entrepreneurs profit at the cost of all others runs in an ever increasing speed. Farming becomes industrialized, widening the gap between farmers and consumers. Minor food safety incidents have a major impact on consumers confidence, causing huge risks for farmers. Only a handful of retailers in Europe control the market for agricultural products, and in their competition to serve the consumer with the lowest possible price, farmers have no influence on the farm gate prices and suffer. Meanwhile, many farmers try survive in niches like local specialties, agri-tourism and short supply chains.*

But what justifies the opinion that this a negative development? Large enterprises can produce cleaner, more efficient and cheaper, with even more care for animal welfare. Without further industrialisation of the agricultural sector there will not be enough food to feed the rapidly growing urbanised world population, as leading experts claim.

In this paper we search for a solid ground for assessing the healthiness of a food chain. Taking farming systems as living ecosystems, food chains should be healthy and responsive: capable of finding new solutions to challenges in an ever changing environment. Could the concept of healthy food chains be a bridge builder between opposing views?

Keywords: *farming system, food chain, innovation, industrialisation of agriculture, power structures, vital systems.*

Food system in crisis

The Dutch agricultural sector has a worldwide reputation for being innovative, and the average Dutch farmer has the highest labour productivity in the World. Nevertheless, only one third of the enterprises in primary agricultural production is making a decent income. Half of the farm households had even zero or negative incomes in 2015. The Dutch landscape will change dramatically within the next ten years (Beers 2016).

Just a few large retail organisations control most of the European market for agricultural products. Consumers profit from the heavy competition between them, but the battle results in ever smaller margins for farmers, who are forced to choose between further intensifying their production, fleeing into a niche market, or abandoning the sector along with their way of life.

This rat race is not limited to The Netherlands. In large areas throughout Europe, where conditions in terms of infrastructure and ecology are less favourable, farmers are struggling for their survival, through focussing on niche markets and additional functions like agri-tourism. Roughly half of the budget of the European Union is spent on direct support to farm incomes just for keeping them alive. In fact, the European consumers are paying for their food twice: in the supermarket and through their tax bills.

But the crisis is more encompassing. Intensive agricultural production systems have caused huge pressure on ecosystems, because of pollution and the abundant use of chemicals, pesticides and antibiotics, as well as deforestation. On the world scale, 60% of the services provided by ecosystems are threatened (Ferwerda 2015). The capacity to feed the World is decreasing because of loss of fertility of soils at a massive scale. Adaptation to climate change is not enough. It will take huge efforts to restore damaged ecosystems, for securing the livelihood for future generations.

We cannot escape from the impression that there is something fundamentally wrong in the way our current food systems are functioning. But what is wrong? And where is the way out?

There are opposing views on the future of agriculture. Two views, dominating the debate, could be summarised as follows:

Clever intensification:

The growing world population, with more and more people living in urban areas, can only be nourished when agricultural productivity further increases. This is possible by further enlargement of scale by modern enterprises that can work more efficiently. Such enterprises have the capital to apply high tech solutions such as precision farming (Fresco and Poppe 2016). Robots can do unattractive work with more precision, 24 hours a day and 7 days a week. Capital intensive enterprises are better able to control conditions for reducing vector diseases, thus limiting the use of pesticides and antibiotics, which can be further decreased by applying genetically modified crops. There are also claims that capital intensive high tech farms can be more energy efficient and animal friendly. For example: the milking robot allows the cow to be milked whenever she pleases.

New enterprises are emerging, producing vegetables under LED light in fully automatic field beds in which all conditions are controlled with high precision. No pesticides are needed. Robots make it possible to grow a great variety of products with specified qualities. Since the entire production is taking place indoor without daylight, it is possible to produce large quantities in multistore factories around the city. Similar systems are in development for the pig industry. Welcome to the future.

Focus on biological and local:

The other view stresses that farming should be embedded in its ecological and social environment. Biological farming aims at maintaining circular ecosystems, keeping balance between what farmers ask from the soil and the animals and what they give back. Healthy animals are resilient, and healthy soils are full of life which prevent them from degradation.

Furthermore, rural landscapes are hard to sustain without farmers who are embedded in their social environment. Without income opportunities in rural areas, people will move to cities and facilities disappear, making life even less attractive for those who stay behind. This is an important reason for the EU to provide direct income support to farmers, based on the land area they possess.

Other claims are that biological food products are more tasty and more healthy than those from the bio-industry, where yields per hectare and production per animal are pushed to their limits with chemical and genetical tricks. Big tomatoes contain more water, and thus have a higher yield in kilograms per hectare, but they have less taste than the small varieties.

A sense of responsibility and consciousness about the quality of food is believed to be stimulated by short links between farmers and consumers. There is an increasing interest among consumers in the origins of their food products. Gradually, people prefer food they can trust, in terms of quality and animal friendly ways of production. They like food with a story. In The Netherlands, the consumption of biological food products rose by 10% in 2016. Yet, the share of the total market is modest: only € 1,4 Billion out of € 58 Billion in total. This share is lower than in Germany or the Scandinavian countries.

Who is right? What criteria enable us to assess which track is better for our common future? Or could both tracks develop further simultaneously, as is happening at present? Then still, it would be useful to have a scientifically sound framework that enables the discussants to rise above the level of opposing beliefs, and evaluate the assumptions in which these beliefs are rooted. A bridge building theory is needed. The following section is an effort to contribute to such a theory.

A Theory of Living Networks

Food chains can be regarded as living networks, which can be more or less healthy, just like ecosystems and living organisms at any scale. If we understand better what organising principles are governing the processes of life, this could provide us with tools to assess trends that contribute to healthiness and alarm signals for negative developments.

What is the nature of life? All living systems are dynamic networks, composed of many components that are coupled through interaction patterns. This is true for singular cells, plants, animals and humans. The same is true for small and large ecosystems, as well as for communities of social animals. There is no reason to make an exception for networks being formed by humans, be it families, local communities, nations, organisations, clubs, and also social networks in the narrow sense of communities for exchanging ideas and experiences without much commitment. Networks are the living tissue that enable people to interact in a meaningful manner (Wielinga 2001).

Literally, a network is a collection of knots that are interconnected. And so it is in the living nature. Every knot is a living network in itself, and every network is a knot in a larger network (Capra 1996). An ecosystem is large network consisting of many smaller networks, and ultimately every ecosystem is part of the biosphere of the Earth, Gaia, which can be regarded as a living network as well (Lovelock 1979).

The difference between living networks and dead matter is in the way energy is being managed. According to the law of entropy, all potential energy in matter decreases to the lowest possible level. Dead organisms decompose into their components. In contrast, living networks are able to absorb energy, process it into living tissue, and make it available for maintaining themselves and for reproduction. In the course of the evolution, ecosystems developed into ever more complex systems, with more specialisation, task division and diversity. And beauty: who ever had the opportunity to walk in a tropical rain forest or to dive between tropical corals must have been impressed by the overwhelming beauty of untouched nature.

Human networks are part of this evolution. Also human history shows a continuous increase in specialisation, task division and complexity. In our time this occurs in an ever increasing speed, up to the world wide web that connects every individual to the entire world in just a few mouse clicks.

What organising principles are basic for energy management systems in living networks? If we could stay close to these principles, we could have more chances to work along with the evolution of life, than when we disobey them. "*In the end, Mother Gaia will strike back*", as Bruno Latour puts it (Latour 2017). She does not need humans, humans need Her. The major challenge of this time is to align human behaviour with the carrying capacity of the world wide ecosystem.

We are living in a period of transition of at least the same importance as the shift towards the Enlightenment at the end of the 18th century: a transition through which people will look differently at each other and at the world around them[1]. The transition from ego-consciousness to eco-consciousness (Scharmer 2013) is taking place, whatever difficulties there still are to overcome. Not self-interest but the awareness of dependency of our natural resources and a common faith will become leading.

Seven organising principles of living networks

Seven organising principles support the Living Networks theory (Wielinga and Robijn 2018). All principles are derived from common and widely accepted scientific theories. Combining them this way is new, and this creates new perspectives for policy, management and facilitation, focussing on the energy management system in networks. Interestingly, all principles are easily recognisable in everyday life. The surprising thing is that it is yet uncommon to describe them in this way.

[1] The principle of self-organisation

Living networks are self-organising. They do not really defy the fundamental law of entropy. They found more efficient ways to absorb energy and to make use of it, by packaging it in a clever way. You can put more cloths in a suitcase by folding them orderly than when by just

[1] Herman Wijffels, former CEO RABO bank / prof. Sustainable Development, personal communication.

throwing them in. After life began in simple molecules which formed interaction patterns that absorbed energy from sunlight, they made more complex chemical structures and bacteria that were able to reproduce themselves. This energy efficiency is the driving force in the evolution of life, pushing towards more specialisation, task division and complexity. Without this driving force life would have got stuck in the primordial soup.

Organisms and ecosystems have in-built mechanisms to keep the processes of life going. Countless feedback loops maintain a dynamic balance between countervailing forces in the cybernetics of living systems as long as all essential components are interconnected. These autopoietic processes ensure that the whole is more than its constituting parts: the network has system properties that cannot be attributed to the elements by which it is composed. Life is an emerging property of a network that has become a system by its interaction patterns.

Human networks are no exception. Social systems are more than the sum of individuals. They provide safety and meaningfulness. If people are well attuned, they can achieve more than the sum of all individuals alone. They make more efficient use of their energy. The system properties of the network represent potential energy. Just like in living systems at other levels of complexity, this energy can be mobilised for maintenance and reproduction of the living network. Social capital is a cleverly packaged form of the same energy we know as sunlight or oil, at a high degree of complexity.

The mechanisms to keep human living networks vital are in-built. This should not be surprising. Humans have been living in social structures for more than 100.000 generations, and their predecessors, the primates, much longer. It is safe to assume that within social structures people are interconnected in many more ways than they are aware of, and that people can feel the signals of disturbance in the social order that call for action earlier than they can reason them out. Likewise, they feel the signals of satisfaction when things go well for the group more directly than what they might admit rationally. In his book "*The age of empathy"* primatologist Frans de Waal shows how empathy plays a crucial role in communities of monkeys. He criticises the assumption that humans would basically be selfish individuals, as neo-liberal economists have tried to make us believe (De Waal 2009).

The living process organises itself, as long as it is not being blocked. Mutual trust grows by itself, as long as it is not being disturbed. A healthy network develops "*vital space*" where people feel protected and meaningful and where they feel the freedom to be curious and creative (Wielinga 2001, 2008). Within this vital space, people experience nourishing energy. Losing energy is a signal for a shrinking vital space. As part of the autopoietic process, there will always be persons who take action to keep the interaction healthy when this is needed. This is, under the condition that they feel connected. Obviously, this is not always the case, as will become understandable while discussing the next organising principles.

[2] The principle of identity

Every living network forms an identity, separating inside from outside. Cells form a cell wall, plants and animals form a skin, and also communities form an identity distinguishing who belongs to it and who does not. The biological function of identity is to create internal conditions that are sufficiently constant for the autopoietic process to continue. For human systems this means that identity provides safety to keep interaction healthy.

The influence of networks on human behaviour is much stronger than has been assumed by hardcore economists who see people as autonomous individuals making rational decisions. Nicolas Christakis and James Fowler have shown that most people are hardly aware of what is directing their minds, but nevertheless strongly influence their networks by their behaviour. (Christakis and Fowler 2009).

Every human individual is simultaneously part of many networks: family, networks of friends, local community, clubs, work teams, professional networks, nations and ultimately the world community. The connections within one network are stronger than within other. It is a matter of consciousness how small or big the network is to which someone feels connected.

As an individual, the smallest network I am dealing with is myself. My system is prone to many influences, and in my mind there are competing feelings and thoughts calling for my

attention. Yet, some consistency is desirable to find my way between other people and to acquire a position where I can feel meaningful. So, my mind has a strong capacity to make things fit (even if they actually don't) into a structure that enables me to act in my environment for staying connected. This is the identity to which I say "Me".

The identity of "We" is more complex. A network to which I say "We" can be "They" for me in another context. Yet, the basic principle is the same. Each network has characteristics that determine who belongs to it, and a structure that forms the living tissue for its internal processes. This structure provides safety, purpose, values, norms, rules, language, rituals, symbols, and order that allows for specialisation and task division. Those who belong to this network must, to a certain extent, act conform this structure for keeping the internal conditions sufficiently safe.

There is a natural tension between the network of "Me" and "We", just as there is between those of "We" and "They". What is good for my own feeling of safety or my personal interests might not be the same as what the "We" network is demanding from me. Only when I feel safe enough myself, I can act effectively in a network with others. Much of the communication in a network is actually about finding out where the borderlines are in the vital space. This is known as the meta-communication beyond the arguments about contents.

[3] The principle of competition

Competition is an essential driving force in nature that pushes towards specialisation and excellence. Without competition there would be no variation and selection, and no task division and complexity. Competition and complementarity, the 4th principle, are each other's counterparts. The fox and the rabbit it is chasing are not aware that together they are part of a complementary mechanism in the ecosystem: for the fox it might be a meal and for the rabbit a matter of life and death. The struggle for life and the survival of the fittest are forces behind the evolution: this discovery made Charles Darwin famous. He understood half of the story, as will be explained with the 4th principle.

Without competition, games and sports are not interesting. In healthy competition also the losers gain in strength and experience. This holds as long as the competition is framed in a safe structure with rules and referees.

When insufficiently controlled by countervailing mechanisms, competitive systems work towards their own limits. (a) In order to win, the system must specialise for making be the best use of the circumstances. This makes it less flexible and thus vulnerable for changes. (b) Specialisation means selection and exclusion of what does not fit. Exclusion provokes counterforces. (3) Competition for survival shortens the horizon of responsibility. Uncontrolled competition leads to exhaustion and pollution, thus destroying the natural sources of existence. Insects causing a plague do not only destroy a yield but also themselves.

[4] The principle of complementarity

Complementarity is what makes complex systems more than their constituting parts. In her theory of endosymbiosis, Lynn Margulis postulated the other half of the evolution theory (Margulis 2008). In the primordial soup, different bacteria developed complementary functions in the primitive ecosystem. Mitochondria, the energy factories in every living cell, originate from independent bacteria that engaged into symbiotic relationships. As the intestinal flora is living in symbiosis with the human body, one could also argue that together they form one organism. Ecosystems consist of an impressive number of collaborative relationships. At the level of the fox and the rabbit it has the character of eat-or-be-eaten, but this relationship is being framed within a larger complementary system with autopoietic mechanisms that keep the system healthy.

Complementarity in human networks allows individuals to specialise in what they can do best, while being confident that others will do their share in what is necessary to make the network function properly.

Hierarchy and task division are never entirely fixed in human networks. Positions are being challenged, individuals keep on weighing the balance between give and take, and evaluate

whether the gain of the network is worth giving up parts of their own freedom and safety. The dynamics within networks are a continuous game between individual and collective identities.

Just like competitive networks, complementary networks work towards their own limitations. Their healthiness depend on the mechanisms that connect the collaborating components. These coupling mechanisms should grow along while a network develops further towards more complexity. Once these feedback mechanisms are no longer capable of doing so, the network becomes vulnerable to competitive systems that eventually destroy them.

[5] The principle of pulsating growth

The heartbeat of life is pulsating. Development goes with ups and downs. Organisms grow, flourish, degrade and die. Networks build structures, and when these structures become too rigid, they miss the flexibility to cope with challenges and destructive processes will take over.

Every living cell has its inhabiting housebreakers, the lysosomes, little bags of enzymes that start their destructive work as soon as the energy supply to their membranes stops. This is how the rotting process starts after an organism dies. Life is a constant battle between constructive and destructive mechanisms. In young organisms the constructive powers are stronger, in the mature stage both mechanisms keep each other balanced, and aging means that destruction is at the winning hand. Destructive mechanisms are always escalating: each step reinforces the next one. The function of this cycle of life is to clean up what does not function properly anymore, in order to create space and nourishment for new forms of life.

Healthy living systems are constantly being probed and attacked, and they should be: this is how they learn how to keep their internal conditions safe in an unsafe environment, and keep their defence system updated.

In nature, periods of complementarity alternate with periods of competition, but the trend in the evolutionary process is towards more complexity with higher levels of collaboration. In human networks this principle can be recognised as well, in periods of smooth sailing and rough waters, booming periods and crisis. Every process of successful change passes a swamp of trouble before finding the right track. The logic is that change requires giving up structures that provided safety before new practices could prove their value.

[6] The principle of abundance

Healthy living organisms produce more than they need for their own survival. Plants produce lots of seeds and fruits. They multiply themselves so abundantly that there is enough food for animals. Animals produce abundant offspring, many of them serving as food for other animals. Redundancy is necessary for variation and selection. Redundant organic material serves the ecosystem as a whole.

Vital space in healthy human networks makes energy available, which allows for learning and creativity, for games and pleasure. When energy slips away, people lose their interest, or the structure becomes so rigid that pleasure turns into fear. When people enter into a survival mode, there is little room for learning and creativity.

When the health of a vital network is in danger, it takes at least one healthy nucleus with a surplus of energy, to do whatever is needed to restore the health of the network. This might be the person that is often referred to as ‘the champion’, the catalyst or the broker. We call such persons ‘Free Actors’, because they take the freedom to do whatever it takes, even when they do not have a mandate for doing so.

The principle can be recognised at this individual level, but also at higher levels of complexity. Every society has its mechanisms to level off profits and to redistribute them where this is needed to keep the society functioning. Think of taxation and services provided by governments, insurances or charity.

[7] The principle of responsiveness

Living organisms can sustain and reproduce themselves as long as they are responsive to changes in their environment. This is more than resilience: the capacity to restore its original

shape after the attack has been tackled. It is also more than adaptivity: the capacity to behave differently when circumstances require to do so. Responsiveness is the capacity to find new answers to new challenges. To some extend the organism reinvents itself. The evolutionary process continues because of this principle of responsiveness. The main mechanism to innovate in the living nature is genetic modification.

The human species developed the capacity to communicate in abstract language. This speeded up the evolutionary process, because cultural changes take place much faster than the genetic track. People create abstract images of reality and tell each other about it. This learning capacity made the human species very successful in its competition with other forms of life. That is, to the point that this competitive stage in the evolution has now reached a point that it threatens its own survival. The human species is destroying its natural resources, technical innovation and financial systems are trapped in an escalating pattern of exponential growth and it is excluding important elements of ecosystems that might become counter-forces beyond control. When, for example, diseases are banned out with antibiotics, the immune system will have no resistance anymore against a mutant virus that breaks through. Likewise, if many people are being excluded from accumulating wealth, they will come to claim their share.

Sustainable development means that a major shift should be made from a predominantly competitive system towards a complementary system. The health of complementary systems depend on the quality of the coupling mechanisms to keep all vital components connected. Consciousness is an essential element of the coupling mechanisms in human networks. This consciousness is framed in belief systems: the stories people tell to each other about the way the World is functioning. The fox and the rabbit do not care about complementarity: the invisible hand of the ecosystem takes care of that. Adam Smith thought that such an invisible hand would also take care for human societies when people would focus on their self-interests. But now, mankind has outgrown the level at which it can rely on ecology to restore the manmade damage. This awareness is the basis of eco-consciousness according to Otto Scharmer (2014).

Considering that ecosystems are basically self-organising, humans are part of the mechanisms through which this occurs. This means that people can receive the alarm signals the system is sending out when its health is being threatened. This is how many people became worried, and why the movement for sustainability is growing. At the same time, people feel responsible for the structures that provide them safety, even though these structures will not provide safety in the long run. When these structures fail to be responsive to the changing environment, destructive mechanisms will take over. Constructive change means connecting in a new way what is not properly connected. The question we should ask ourselves is: are we feeding the destructive or the constructive patterns?

The evolution of the Dutch food system as a living network

How does this theory of living networks help us to assess the health of a food system? Two examples will be examined. First, we look at the remarkable post war history of the Dutch food system. What made Dutch farmers so successful? And what went wrong? How healthy is the system now? Or should we assess different subsystems with their own development? Secondly, we examine the approach for regenerative landscapes as an example of what is possible while staying close to the organising principles of living networks.

Self-organisation and identity: favourable conditions for growth

In the years of reconstruction after World War II, agriculture was top priority in Dutch government policies. Food production should increase dramatically to overcome the famine at the end of the war. All efforts were focussed on *"the average family farm household that should earn a decent income"*, as the first post war Minister of Agriculture, Sicco Mansholt, said. The Marshall help from the USA provided new techniques and equipment, such as tractors. The public extension service was upgraded and created short lines between

farmers, researchers and policy makers. Active price policy with guaranteed bottom prices for essential food products made sure that average farmers could earn a living.

Community development was a major component of the Government program for improving the capacity of self- organisation of the farming sector. Farmers organisations did become strong indeed, and farmers cooperatives organised their input supply, processing, marketing and credit facilities. The "Green Front", consisting of farmers leaders, researchers and politicians, felt jointly responsible for creating favourable conditions for the average Dutch family farming household.

The approach was so successful that Mansholt moved to Brussels in 1956 as the first European Commissioner for Agriculture, with the mission to repeat the Dutch miracle at European scale. The Dutch agricultural sector had developed a strong identity, with a feeling of interdependency and co-responsibility. In the vital space that emerged, Dutch farmers became remarkably innovative.

Competition and complementarity: strong incentives for development

In the end of the '50 Dutch farmers produced more than enough food for the national consumption. Growth could only continue if the focus would shift to the World market. In order to be competitive, specialisation and task division was necessary. Farmers had to specialise in one sector and increase their farm size. Those who could not keep up were bought out and they easily found work in other economic sectors that were rapidly growing as well. Apart from production growth, efficiency became a major item. The Dutch sector as a whole was now competing with the outside world. Within the sector actors felt co-responsible and they shared information and experiences in an open knowledge system, strongly facilitated by the state.

Due to their strong influence on the retail market, for some decades Dutch farmers escaped to some extent from the treadmill that Cochrane (1958) described. Innovators and early adopters profit from innovations because they can produce more efficiently. More supply to the market causes prices to go down, and other farmers are forced to adopt the innovation if they want to keep the same income. Those who cannot cope with the changes go bankrupt. As a result, innovations cause the majority of the farmers to work harder and take more risks without earning higher incomes.

Negative side effects

In the flourishing period, the Dutch farming network seemed vital at the scale of the food system, but at a larger scale it was not. The Green Front had become so strong that it could ignore alarm signals for a long time. Feedback mechanisms between the farming sector and the rest of society had been disabled. The negative by-effects of the intensive production system, such as pollution and overproduction, had just been thrown over the fence of society. By the time society did not accept this anymore in the '80ies, the bill for cleaning up the mess had become very high.

At the European level similar problems came to the surface. The guaranteed bottom prices for milk, butter, meat and wine had led to overproduction, causing high costs for tax payers, and disturbance of the World market for food products. Import levies and export subsidies made it hard for countries outside the European Community to compete. The European food system clearly had entered an unleashed competitive stage with detrimental effects.

Pulsating growth: from one big structure to many smaller ones

In the end of '80ies, the Dutch Green Front with its focus on productivity failed to respond adequately to the crisis caused by pollution and overproduction. The Ministry of Agriculture, that always had been a stimulating partner, now had to change its role towards containing the damage. The scientist from Wageningen were torn apart between opposing interests, and lost their status of independent guides showing the best way. When problems are complex and interests are conflicting, uncontested truth is hard to find. In the '90ies the "Green Front" collapsed, and fell apart in a patchwork of smaller networks, all fighting for

their own interests. Dutch farmers got trapped in the treadmill as well, resulting in the income distribution as mentioned at the start of this paper. The number of registered farm enterprises dropped from 450.000 in 1950 to 135.000 in 1990 and 55.000 in 2017.

Abundance and scarcity: thresholds for free actors

In the flourishing years of Dutch agriculture, there was an army of 'free actors' available to keep all key actors connected: the public extension service. As these knowledge workers were in close contact with farmers and committed to the common purpose, little direction was given to the results they had to achieve. The threshold to do what they found necessary to do was low, and thus they were active in a wide range of network activities within their sector.

This changed dramatically after the public extension service turned into a privatised advisory service in the '90ies. Advisors had to reach their commercial targets, and no time was left to spend on connecting activities. The glue disappeared from the system. Each subsystem organised itself, at the risk of creating their own mental silos[2], competing with other stakeholders in society just in order to survive.

Public funding changed from input to output financing, requiring accountable results. Per definition, free actor activities are hard to be accounted for, because it cannot be foreseen what will be needed at a given point in time. Thus, the threshold for free actors became high.

An unleashed competitive system does not produce abundance but scarcity, with margins becoming smaller for all stakeholders. When all actors in a network feel forced into a survival mode, none of them will survive in the end.

Big steps as an illustration

In this review we rushed through the history of the Dutch food system with big steps, without bothering about details, just to illustrate what can be seen through the perspective of living networks. It enables us to see the food system as part of the entire ecosystem. Difficulties arose when the farming sector had built a structure that was unable to stay connected with the larger system. The sector fell apart in many smaller subsystems, some very successfully making use of the heritage of the old days. But it looks like changes are urgently needed to convert the competitive stage with its detrimental effects into a more complementary stage of development, based on the recognition of mutual dependency and respect for the ecological sources of existence.

What could such an interconnected approach look like? Before drawing conclusions on the assessment of the healthiness of food systems, we describe an example of a large scale approach, based on the common understanding of major stakeholders within the system that they have to act collectively on a serious threat that affects them all.

The example of mosaic landscapes for ecosystem restoration

4 returns, 3 zones and 20 years (Ferwerda, 2015)

For many areas in the World, efforts for balancing People, Planet and Profit are not enough. Maximisation of Return on Investment per hectare leads to ecosystem degeneration UNEP[3], UNCCD[4] and WRI[5] estimate that worldwide 2 billion hectares are degenerated and the 60% of the services provided by ecosystems[6] are threatened. The ambition should be higher than

[2] Subgroups, reinforcing each other in their own truth

[3] United Nations Environmental Programme

[4] UN Convention to Combat Desertification

[5] World Resources Institute

[6] *Provisioning services* (food, pharma ingredients), *Regulating services* (carbon sequestration, waste decomposition, purification of water, climate regulation), *Supporting services* (nutrient dispersal and

reducing negative impact. In order to safeguard the livelihood of future generations, damage that has been made needs to be restored through regenerative food systems.

Large scale projects like the Chinese Loess Watershed Rehabilitation Project in the provinces of Shanxi, Shaanxi and Gansu, and the Inner Mongolia Autonomous Region, as well as by the Foundation for Ecological Security in India and the Regreening Niger, have shown that it is possible to bring back ecological and economic viability with collaboration in a long term commitment.

The "Commonland" foundation[7], led by Willem Ferwerda, developed the "4 returns, 3 zones and 20 years" approach, which yielded promising results in Baviaanskloof, South Africa, Altiplani de Vélez, Spain. Key elements of this approach are:

- *4 returns:*
    - Inspiration
    - Social capital
    - Natural capital
    - Financial capital
- *3 zones:*
    - Natural zone
    - Eco-agro mixed zone
    - Economic zone
- *20 years:*
    - Long term partnerships between farmers, business, financers, science and politics
    - Joint Learning Process through the U-turn approach for deep transformation (Scharmer 2013)

This approach illustrates to a large extent what working along the organising principles in living networks could look like in practice. A shared recognition of the damage that is threatening the common future in the area, and the perspective of good solutions for restoration provide a strong basis for a joint ambition that reinforces the identity of the network. The long term commitment is necessary to create safe conditions for all partners to invest their time and effort.

Competition is not necessarily ruled out, but framed within the complementarity of the mosaic landscape, dividing necessary functions over areas most suitable for them. The approach puts emphasis on co-creation, which requires a strong role of a free actor who is in the position to keep the partners connected throughout the process. A strong commitment to the area makes it likely that surplus being generated will be reinvested within the area where this is needed for the common good.

Maybe this picture has an element of wishful thinking. Ferwerda admits that the most difficult part is to get businesses on board. For companies with a focus that merely goes beyond the next shareholders meeting it is hard to commit themselves for a period of 20 years. But also among entrepreneurs and business leaders there are people who made the shift towards eco-consciousness.

Conclusions:

- The health of a food system includes more than production yields, efficiency, farm income and consumer prices. It should be considered as part of an ecosystem, which is healthy:
    - when it adds to healthy soils and animals,

recycling, primary production, infrastructure and housing), *Cultural services* (cultural and intellectual inspiration, recreational experiences). Millennium Eco Systems Assessment (2005).

[7] Commonland Foundation, supported by COmON foundation, the IUCN Commission on Ecosystem Management and Rotterdam School of Management, Erasmus University.

  - when it adds to the evolutionary process of increasing complementarity with specialisation, task division and diversity,
  - when it produces purpose and livelihood to people, and
  - when it is capable of responding adequately to changes in the environment.
- Escalating patterns are alarm signals, indicating that destructive processes are taking over. For example:
  - When the use of antibiotics is increasing each year,
  - When soils needs more artificial fertilizer for the same harvest,
  - When farmers work harder every year for less income.
  - Restrictive rules and laws become more detailed and control takes ever more effort while fraud becomes more profitable.
- For food systems to be healthy, there should be mechanisms to maintain complementarity. The biggest challenge is to balance efforts and profits in a fair way among the partners in a food chain.
- A fair balance between give and take is easier to achieve in networks with a regional scope and a clear common purpose, such as the regeneration of degraded areas, or branding a region as biological and authentic for attracting tourists.
- The path of clever intensification is not inherently unhealthy in ecological terms. It leads to systems with further advanced specialisation and task division. High tech solutions allow for further diversification, as well as the reduction of negative impacts through precision farming.
- The risks of the path of clever intensification are higher:
  - Keeping balance between effort and profit throughout the chain is more difficult.
  - High levels of disease control weaken the natural immune systems of animal and vegetable food sources, making them more vulnerable for attacks by micro-organisms.
  - It takes huge efforts to maintain thrust among consumers who have little connection with their sources of food. Small incidents lead to big losses for entrepreneurs, even though they did everything within their competence to prevent them.
- A healthy network produces abundance. It remains healthy when surplus is reinvested in the network.
- A healthy network requires ‘free actors’ who take action for keeping partners connected. They use their surplus of energy for investing it in the network where it is needed most to stay healthy. The height of the threshold for free actors is an indicator of healthiness of the network. A high threshold makes intervention more risky for the free actor. There will always be hero’s, but in a rigid regime they will be less numerous, which reduces the responsive capacity of the network.
- Cynicism is an alarm signal. Cynical people sense a destructive process but they have given up their resistance.
- Improving the health of a system can start small. A healthy nucleus is the free actor for a larger network.
- The smallest healthy nucleus to act as a free actor is an individual who takes an initiative for the benefit of the network. It is your choice to be one or not.

The Living Networks theory does not lead to a rejection of either the clever intensification approach or the biological local approach. However, the clever intensification track is more demanding and involves higher risks, since it is more difficult to maintain the necessary

feedback mechanisms between producers and their consumers, thus posing risks for mistrust. Small incidents can have disastrous effects. Furthermore, the artificial ecosystems being created move further away from natural processes in ecology where nature takes care of the active balance between healthy organisms and their constant threateners. When natural immune systems are being disabled, artificial control systems have to take over. There might be an end to the level at which this is possible. Probably we need both approaches simultaneously.

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